# Benthic TMDL Development:

# Stressor Identification for Bull Run, Virginia

**Submitted to**

***Virginia Department of Environmental Quality***

**Prepared by**

THE Louis Berger Group, INC.
2300 N Street, NW
Washington, DC 20037

**December 2005**

# DRAFT REPORT

# 1.0 Introduction

Total Maximum Daily Load (TMDL) development for biological impairment requires a methodology to identify impairment causes and to determine pollutant reductions that will allow streams to attain their designated uses. The identification of the pollutant(s), or *stressor(s)*, responsible for the impaired biological communities is an important first step in developing a TMDL that accurately specifies the pollutant load reductions necessary for the stream to comply with Virginia's water quality standards. This report details the steps used to identify and characterize the stressor(s) responsible for biological impairments in Bull Run, Virginia. The first section of this report presents the regulatory guidance and defines the applicable water quality criteria for biological impairment. In the subsequent sections of this report, watershed and environmental monitoring data collected on Bull Run are presented and discussed. Stressors which may be impacting the creek are then analyzed in the stressor identification section. Based on this analysis, candidate stressors impacting benthic invertebrate communities in the creek are identified. A TMDL will be developed for the stressor identified as the primary source of biological impairment in Bull Run.

## *1.1 Regulatory Guidance*

Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA's) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are exceeding water quality standards. TMDLs represent the total pollutant loading that a waterbody can receive without violating water quality standards. The TMDL process establishes the allowable loadings of pollutants for a waterbody based on the relationship between pollution sources and instream water quality conditions. By following the TMDL process, states can establish water quality based controls to reduce pollution from both point and non-point sources to restore and maintain the quality of their water resources (EPA, 2001).

DRAFT

The state regulatory agency for Virginia is the Department of Environmental Quality (DEQ). DEQ works in coordination with the Virginia Department of Conservation and Recreation (DCR), the Department of Mines, Minerals, and Energy (DMME), and the Virginia Department of Health (VDH) to develop and implement a more effective TMDL process. DEQ is the lead agency for the development of TMDLs statewide and focuses its efforts on all aspects of reduction and prevention of pollution to state waters. DEQ ensures compliance with the Federal Clean Water Act and the Water Quality Planning Regulations, as well as with the Virginia Water Quality Monitoring, Information, and Restoration Act (WQMIRA, passed by the Virginia General Assembly in 1997), and coordinates public participation throughout the TMDL development process. The role of DCR is to initiate non-point source pollution control programs statewide through the use of federal grant money. DMME focuses its efforts on issuing surface mining permits and National Pollution Discharge Elimination System (NPDES) permits for industrial and mining operations. Lastly, VDH classifies waters for shellfish growth and harvesting, and conducts surveys to determine sources of contamination (DEQ, 2001).

As required by the Clean Water Act and WQMIRA, DEQ develops and maintains a listing of all impaired waters in the state that details the pollutant(s) causing each impairment and the potential source(s) of each pollutant. This list is referred to as the Section 303(d) List of Impaired Waters. In addition to Section 303(d) List development, WQMIRA directs DEQ to develop and implement TMDLs for listed waters (DEQ, 2001). DEQ also solicits participation and comments from watershed stakeholders and the public throughout the TMDL process. Once TMDLs have been developed and the public comment period has been completed, the TMDLs are submitted to EPA for approval.

## *1.2 Impairment Listing*

Bull Run was initially listed on Virginia's 1994 Section 303(d) List, and was subsequently included on Virginia's 1998 and 2002 Section 303(d) Lists of Impaired Waters (DEQ, 1998; 2002) and in the 2004 Water Quality Assessment 305(b)/303(d) Integrated Report (DEQ, 2004) because of violations of General Standard (benthic

DRAFT

impairment). Bull Run was also listed on the 2004 Water Quality Assessment 305(b)/303(d) Integrated Report due to exceedances of the water quality standards for fecal coliform bacteria and PCB concentrations in fish tissue samples. This report addresses the benthic impairment; the bacteria and PCB impairments will be addressed in separate TMDL reports. Biological assessments conducted at DEQ monitoring station 1ABUL010.28, located at the intersection of Bull Run and Route 28, indicate a moderately impaired benthic macroinvertebrate community, which resulted in the Section 303(d) listing.

Bull Run is located in the northern region of Virginia, and is a tributary of the Occoquan Reservoir drainage. Bull Run flows through sections of Loudoun, Prince William, and Fairfax Counties, as well as the Cities of Fairfax, Manassas, and Manassas Park. The impaired benthic segment of Bull Run (VAN-A23R-01) is 4.8 miles in length extending from the confluence of Cub Run with Bull Run and continuing downstream to the confluence of Popes Head Creek with Bull Run. Figure 1-1 depicts the impaired benthic segment of Bull Run, as well as the delineated watershed boundary.

DRAFT

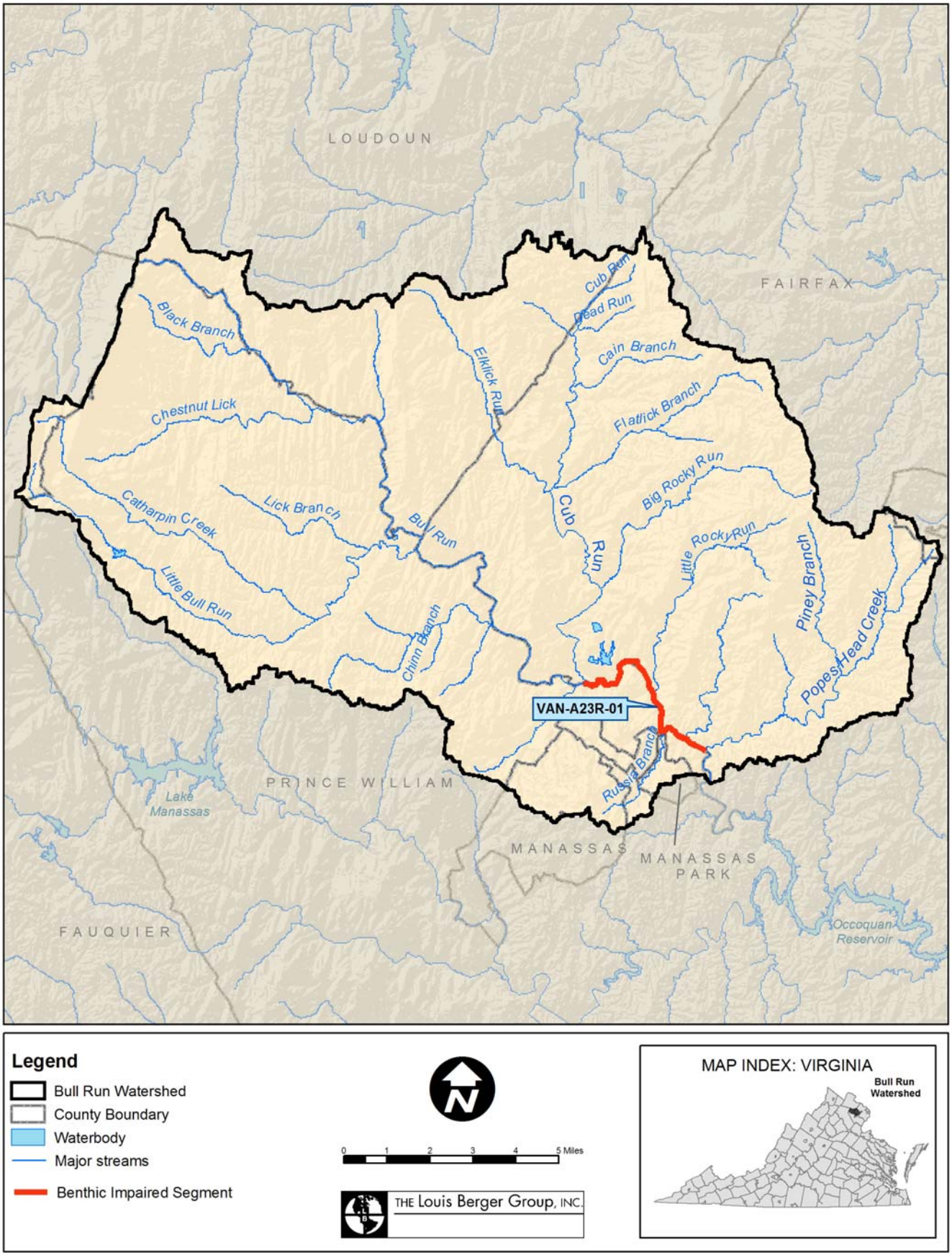


**Figure 1-1: Bull Run Impaired Segment and Delineated Watershed**

## *1.3 Applicable Water Quality Standard*

Water quality standards consist of designated uses for a waterbody and water quality criteria necessary to support those designated uses. According to Virginia Water Quality Standards (9 VAC 25-260-5), the term *water quality standards* "means provisions of state or federal law which consist of a designated use or uses for the waters of the Commonwealth and water quality criteria for such waters based upon such uses. Water quality standards are to protect public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law (§62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC §1251 et seq.)."

### 1.3.1 Designated Uses

According to Virginia Water Quality Standards (9 VAC 25-260-10):

> *"all state waters are designated for the following uses: recreational uses (e.g., swimming and boating); the propagation and growth of a balanced indigenous population of aquatic life, including game fish, which might be reasonably expected to inhabit them; wildlife; and the production of edible and marketable natural resources (e.g., fish and shellfish)."*

The listed segment defined in Section 1.2 does not support the propagation and growth of aquatic life in Bull Run, based on the biological assessment surveys conducted on the stream.

### 1.3.2 Water Quality Criteria

The General Standard defined in Virginia Water Quality Standards (9 VAC 25-260-20) provides general, narrative criteria for the protection of designated uses from substances that may interfere with attainment of such uses. The General Standard states:

> *"All state waters, including wetlands, shall be free from substances attributable to sewage, industrial waste, or other waste in concentrations, amounts, or combinations which contravene established standards or*

DRAFT

*interfere directly or indirectly with designated uses of such water or which are inimical or harmful to human, animal, plant, or aquatic life."*

The biological assessments conducted on Bull Run indicate that some pollutant(s) are interfering with attainment of the General Standard, as impaired invertebrate communities have been observed in the listed segment of the creek. Although biological assessments are indicative of the impacts of pollution, the specific pollutant(s) and source(s) are not necessarily known based on biological assessments alone.

DRAFT

# 2.0 Watershed Characterization

The physical conditions of Bull Run were characterized using a geographic information system (GIS) developed for the watershed. The purpose of the characterization was to provide an overview of the conditions in the watershed related to the benthic impairment present in the listed segment of the stream. Information contained in the watershed GIS was used in the stressor identification analysis, as well as for the subsequent TMDL development. In particular, physical watershed features such as topography, soils types, and land use conditions were characterized. In addition, the number and location of permitted discharge facilities and DEQ monitoring stations in the watershed were summarized.

## *2.1 Physical Characteristics*

Important physical characteristics of the Bull Run watershed that may be contributing to the benthic impairment were analyzed using GIS coverages developed for the area. GIS coverages for the watershed boundary, stream network, topography, soils, land use, and ecoregion of the watershed were compiled and analyzed.

### 2.1.1 Watershed Location and Boundary

Bull Run is located in the northern region of Virginia, and is a tributary of the Occoquan River. Bull Run flows through sections of Loudoun, Prince William, and Fairfax Counties, as well as the Cities of Fairfax, Manassas, and Manassas Park (**Figure 2-1**). The watershed is approximately 118,096 acres or 184.5 square miles.

### 2.1.2 Stream Network

The stream network for the Bull Run watershed was obtained from the USGS National Hydrography Dataset (NHD). The stream network and benthic impairment segment are presented in **Figure 2-1**.

DRAFT

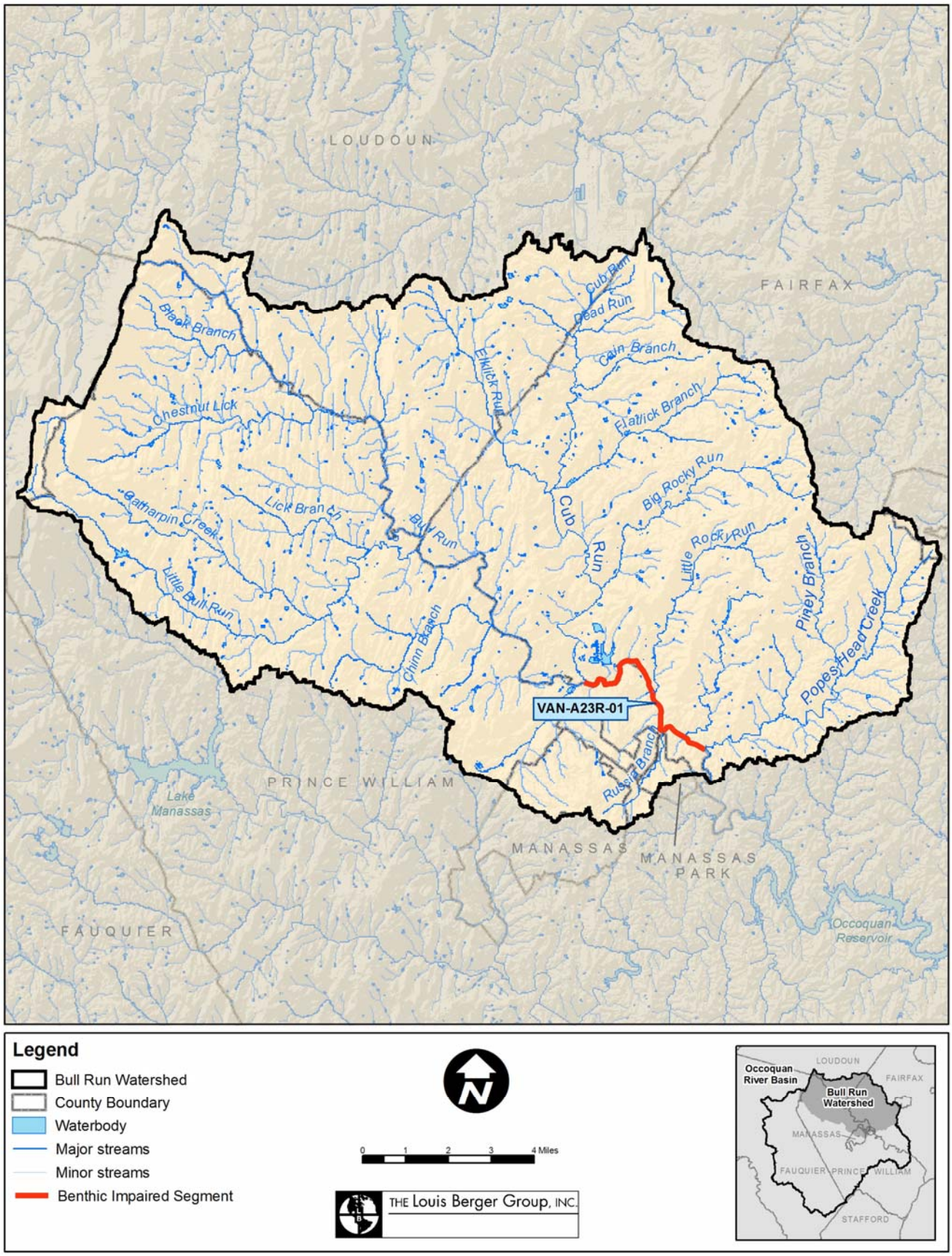


**Figure 2-1: Stream Network for the Bull Run Watershed**

### 2.1.3 Topography

A digital elevation model (DEM) was used to characterize topography in the watershed. DEM data obtained from BASINS show that elevation in the watershed ranges from approximately 108 to 1,242 feet above mean sea level, with an average elevation of 321 feet above mean sea level.

### 2.1.4 Soils

The Bull Run watershed soil characterization was based on the NRCS State Soil Geographic (STATSGO) Database for Virginia. There are six general soil associations present in the Bull Run watershed; Catoctin-Myersville-Rock Outcrop, Codorus-Hatboro-Kinkora, Braddock-Dyke, Buckhall-Occoquan-Meadowville, Penn-Croton-Calverton, Airmont-Stumptown-Weverton, Jackland-Waxpool-Catlett, Brecknock-Kelly-Croton, and Manor-Glenelg-Chester. The majority of soils in the watershed are comprised of the Penn-Croton-Calverton and Brecknock-Kelly-Croton soil associations. The distribution of soils in the Bull Run watershed, along with the hydrologic soil groups of each of the soils associations, is presented in **Table 2-1**.

**Table 2-1: Soil Types in the Bull Run Watershed**

| Map Unit ID | Soil Association | Percent | Hydrologic Soil Group |
|---|---|---|---|
| VA006 | Catoctin-Myersville-Rock Outcrop | 0.1 | B/C |
| VA010 | Codorus-Hatboro-Kinkora | 1.4 | B/C/D |
| VA012 | Braddock-Dyke | 0.5 | B |
| VA013 | Buckhall-Occoquan-Meadowville | 3.2 | B |
| VA015 | Penn-Croton-Calverton | 45.3 | B/C |
| VA021 | Airmont-Stumptown-Weverton | 3.0 | B/C |
| VA022 | Jackland-Waxpool-Catlett | 11.2 | B/C/D |
| VA023 | Brecknock-Kelly-Croton | 23.0 | B/C/D |
| VA071 | Manor-Glenelg-Chester | 12.3 | B/C/D |
| Source: State Soil Geographic (STATSGO) Database for Virginia | | | |

DRAFT

Hydrologic soil groups represent the different levels of soil infiltration capacity. Hydrologic soil group "A" designates soils that are well to excessively well drained, whereas hydrologic soil group "D" designates soils that are poorly drained. This means that soils in hydrologic group "A" allow a larger portion of the rainfall to infiltrate and become part of the groundwater system. On the other hand, compared to the soils in hydrologic group "A", soils in hydrologic group "D" allow a smaller portion of the rainfall to infiltrate and become part of the groundwater, resulting in more rainfall delivered to surface waters in the form of runoff. Descriptions of the hydrologic soil groups are presented in **Table 2-2**.

**Table 2-2: Descriptions of Hydrologic Soil Groups**

| Hydrologic Soil Group | Description |
|---|---|
| A | High infiltration rates. Soils are deep, well drained to excessively drained sand and gravels. |
| B | Moderate infiltration rates. Deep and moderately deep, moderately well and well-drained soils with moderately coarse textures. |
| C | Moderate to slow infiltration rates. Soils with layers impeding downward movement of water or soils with moderately fine or fine textures. |
| D | Very slow infiltration rates. Soils are clayey, have high water table, or shallow to an impervious cover |

### 2.1.5 Land Use

The land use characterization for the Bull Run watershed was based on land cover data from both the Northern Virginia Regional Commission (NVRC) 2000 Land Use Dataset, and the 1992 USGS National Land Cover Data (NLCD). The NVRC dataset was the most recent available land use dataset, and was also utilized in order to be consistent with other ongoing modeling efforts within the Occoquan watershed. However, the NVRC dataset does not specify forested or open (i.e., pasture) lands; therefore, the NLCD dataset was used to fill in the remaining areas. The distribution of land uses in the Bull Run watershed, by land area and percentage, is presented in **Table 2-3**. Developed lands (38.8%), forested lands (34.2%) and agricultural lands (22.6%) represent the dominant land use types in the watershed. **Figure 2-2** displays a map of the land uses within the watershed.

DRAFT

**Table 2-3: Bull Run Watershed Land Use Distribution**

| General Land Use Category | Specific Land Use Type | Acres | Percent of Watershed | Total Percent |
|---|---|---|---|---|
| **Water/ Wetlands** | Open Water | 343.7 | 0.4 | 1.3 |
| | Woody Wetlands | 946.7 | 0.8 | |
| | Emergent Herbaceous Wetlands | 147.1 | 0.1 | |
| **Developed** | Low Intensity Residential | 16076.5 | 13.6 | 38.8 |
| | Medium/High Intensity Residential | 16260.9 | 13.8 | |
| | Commercial/Industrial | 10811.6 | 9.2 | |
| | Institutional | 2595.6 | 2.2 | |
| **Agriculture** | Pasture/Hay/Livestock | 19283.3 | 16.3 | 22.6 |
| | Row Crop | 7486.5 | 6.3 | |
| **Forest** | Deciduous Forest | 29292.3 | 24.8 | 34.2 |
| | Evergreen Forest | 7142.0 | 6.0 | |
| | Mixed Forest | 4025.7 | 3.4 | |
| **Other** | Quarries/Strip Mines/Gravel Pits | 40.7 | 0.03 | 3.1 |
| | Transitional | 628.4 | 0.5 | |
| | Urban/Recreational Grasses | 3015.0 | 2.6 | |
| **Total** | | **118,096** | **100** | **100** |

DRAFT

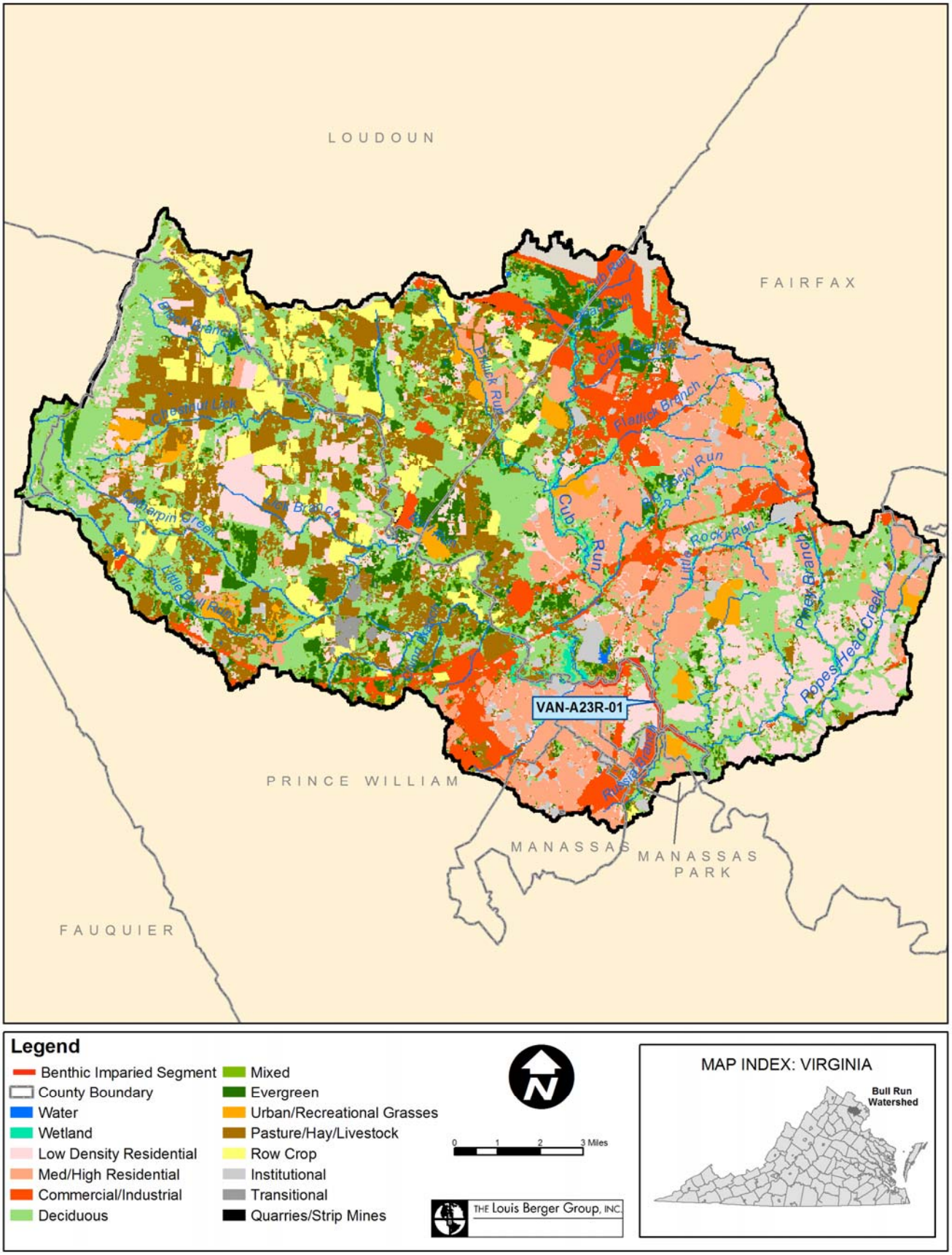


**Figure 2-2: Land Use in the Bull Run Watershed**

### 2.1.6 Ecoregion Classification

The Bull Run watershed is located in the Northern Piedmont and Piedmont ecoregions, USEPA Level III classification numbers 64 and 45, respectively (Woods et al., 1999). The location of the Bull Run watershed within these ecoregions is presented in **Figure 2-3**; the majority of the watershed is encompassed by the Northern Piedmont ecoregion. The Northern Piedmont ecoregion is transitional region of low rounded hills, irregular plains, and open valleys that serves as a transitional area between the low mountains to the north and west and the flat coastal plains to the east. Natural vegetation in the Northern Piedmont ecoregion is predominantly Appalachian oak forest, in contrast to the mostly oak-hickory-pine forests of the Piedmont ecoregion to the southwest.

The Piedmont ecoregion extends from Wayne County, Pennsylvania southwest through Virginia, and comprises a transitional area between the mostly mountainous ecoregions of the Appalachians to the northwest and the flat coastal plain to the southeast. Once largely cultivated, much of this region has reverted to pine and hardwood woodlands. The Piedmont ecoregion is characterized by shallow valleys, irregular plains, and low rounded hills and ridges. The underlying geology of this region consists of deeply weathered, deformed metamorphic rocks with intrusions by igneous material.

DRAFT

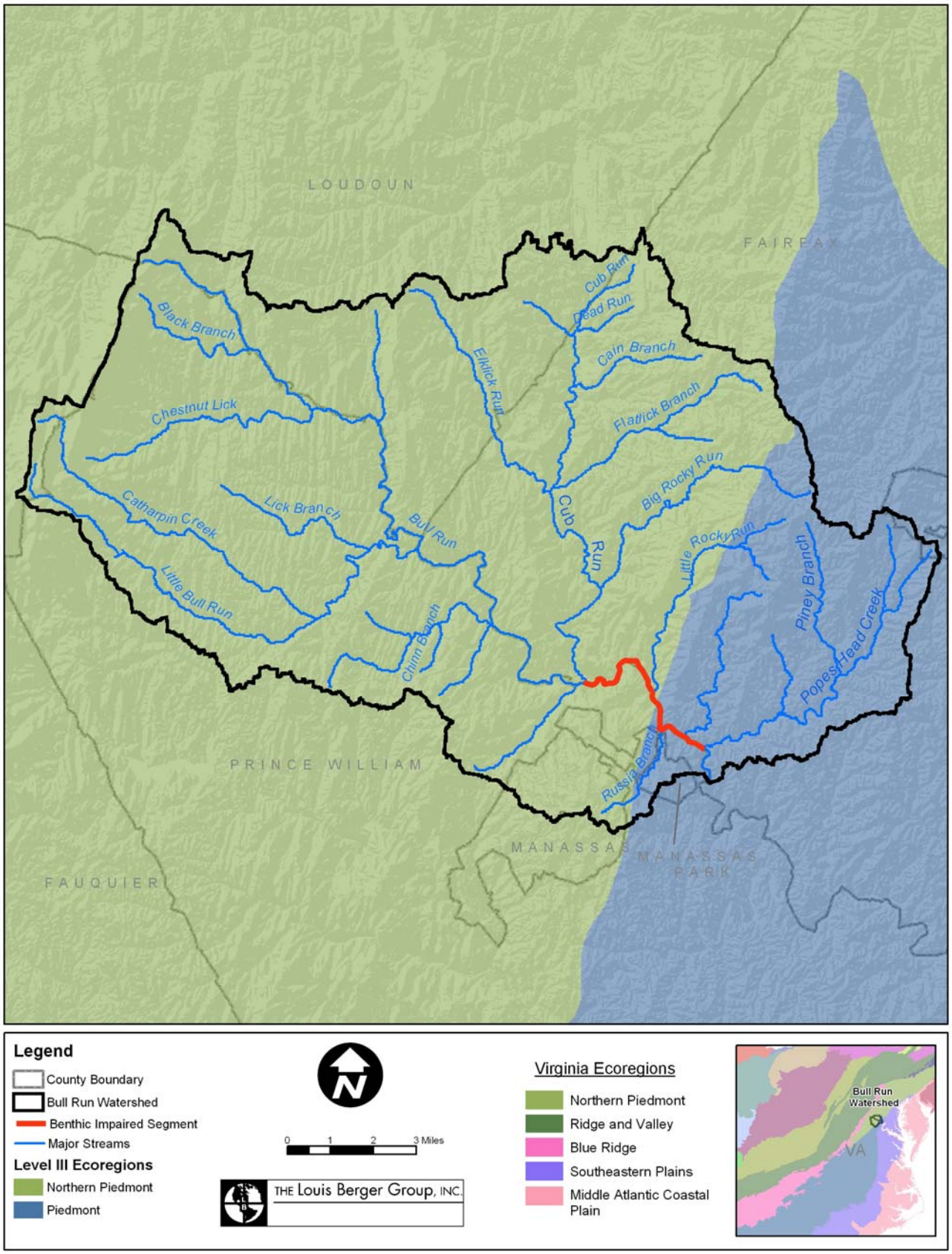


**Figure 2-3: Virginia Level III Ecoregions**

## 2.2 Permitted Discharge Facilities

There are 9 facilities holding active individual discharge permits, issued through the Virginia Pollutant Discharge Elimination System permitting program, in the Bull Run watershed. The permit number, outfall number, permitted flow, receiving waterbody, of the facilities holding individual permits are presented in **Table 2-4** and their locations are presented in **Figure 2-4**. Based on information from DEQ, there are also a total of 132 active general permits in the watershed; 81 stormwater permits issued to construction sites, 32 permits issued to domestic sewage facilities, 8 stormwater permits issued to industrial sites, 5 permits issued to concrete facilities, 3 permits issued to mines, and 3 permits issued for petroleum-related activities. [Additional information on recent MS4 and general construction permits is forthcoming from DCR]. A list of General permit holders is presented in Appendix A.

**Table 2-4: Facilities Holding Individual Permits in the Bull Run Watershed**

| Permit No. | Facility Name | Outfall No. | Design Flow (MGD) | Facility Type | Receiving Waterbody |
|---|---|---|---|---|---|
| VA0024988 | UOSA – Centreville | 1 | 54 | Municipal | Bull Run, UT |
| VA0051683 | Colonial Pipeline - Chantilly | 1 | 0.44 | Industrial | Little Rocky Run, UT |
| | | 101 | - | Industrial | Little Rocky Run, UT |
| | | 102 | - | Industrial | Little Rocky Run, UT |
| VA0051691 | Colonial Pipeline – Bull Run | 1 | 0.06 | Industrial | Bull Run, UT |
| | | 2 | 0.06 | Industrial | Bull Run, UT |
| VA0085901 | IBM Corp | 3 | 0.504 | Industrial | Flat Branch, UT |
| | | 4 | 0.504 | Industrial | Flat Branch, UT |
| VA0087858 | Sunoco - Manassas Terminal | 1 | 2.215 | Industrial | Bull Run, UT |
| | | 2 | - | Industrial | Bull Run, UT |
| | | 101 | - | Industrial | Bull Run, UT |
| VA0087891 | Evergreen Country Club | 1 | 0.008 | Municipal | Chestnut Lick, UT |
| VA0089541 | MWAA - Washington Dulles International Airport | 22 | - | Industrial | Cub Run |
| | | 23 | - | Industrial | Cub Run, UT |
| | | 24 | - | Industrial | Cub Run, UT |
| | | 25 | - | Industrial | Dead Run |
| | | 27 | - | Industrial | Cub Run, UT |
| | | 28 | - | Industrial | Cub Run, UT |
| | | 29 | - | Industrial | Cub Run, UT |
| | | 30 | - | Industrial | Cub Run, UT |
| VA0090441 | Adaptive Concrete Solutions | 1 | - | Industrial | Sand Branch |
| | | 2 | - | Industrial | Sand Branch, UT |
| VA0091430 | Loudoun Composting | 1 | - | Industrial | Sand Branch, UT |

[Note: The information in this table is based on data from DEQ. Additional information on general permits is forthcoming from DCR]

DRAFT

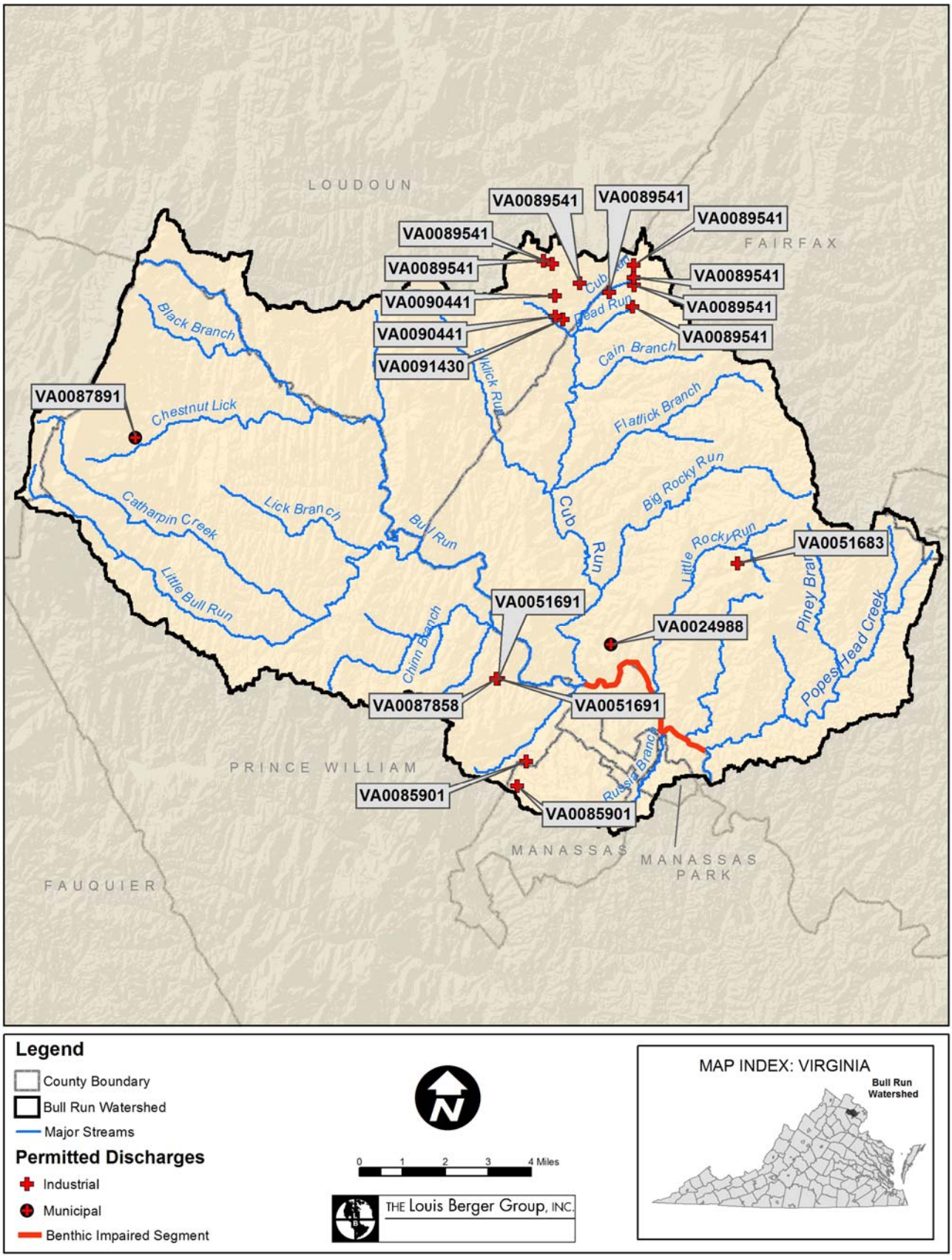


**Figure 2-4: Location of Dischargers with Individual Permits in the Bull Run Watershed**

## 2.3 DEQ Monitoring Stations

DEQ has monitored ambient water quality, macroinvertebrate communities, and/or sediment chemistry at 18 locations in the Bull Run watershed, 7 of which are located on the Bull Run mainstem. A list of those DEQ monitoring stations on the Bull Run mainstem is provided in **Table 2-5**. The locations of these mainstem stations, in addition to the other 11 stations in the watershed, are presented in **Figure 2-5**. Station identification numbers include the abbreviated creek name and the river mile on that creek where the station is located. The river mile number represents the distance from the mouth of the creek. Monitoring data from all stations in the watershed was evaluated as part of the benthic stressor analysis; however, those sites on the Bull Run mainstem are the primary focus for discussion and data presentation for this report.

Monitoring stations 1ABUL010.28, 1ABUL011.03, and 1ABUL025.94 all contain extensive ambient water quality data records; recent ambient monitoring data has also been collected at all of these stations. Biological monitoring data has been collected at station 1ABUL010.28 and recently at stations 1BUL009.61 and 1ABUL011.12. Bull Run was classified as impaired based on the results of bioassessment surveys conducted at station 1ABUL010.28. A detailed discussion of the available environmental monitoring data is presented in *Section 3.0*.

**Table 2-5: Summary of VA DEQ Monitoring Stations on Bull Run**

| Station ID | Station Type | Period Of Record |
|---|---|---|
| 1ABUL009.61 | Biological | 2005 |
| 1ABUL010.28 | Ambient, Biological, and Sediment | 1978-2004 |
| 1ABUL011.03 | Ambient Water Quality | 1971-2004 |
| 1ABUL011.12 | Biological | 2005 |
| 1ABUL013.40 | Sediment | 2004 |
| 1ABUL016.31 | Ambient Water Quality | 1975-1976 |
| 1ABUL025.94 | Ambient Water Quality | 1976-2004 |

DRAFT


**Figure 2-5: DEQ Monitoring Stations in the Bull Run Watershed**

## 2.4 Overview of the Bull Run Watershed

Developed lands (38.8%), forested lands (34.2%) and agricultural lands (22.6%) represent the dominant land uses in the Bull Run watershed. There are 9 facilities holding active individual discharge permits in the watershed, and 132 facilities holding active general permits. Monitoring has been conducted by DEQ at stations 1ABUL09.61, 1ABUL010.28, 1ABUL011.03 and 1ABUL011.12 on the biologically impaired segment of Bull Run, in addition to monitoring conducted at 14 other stations in the watershed.

DRAFT

# 3.0 Environmental Monitoring

Environmental monitoring efforts in the Bull Run watershed include benthic community sampling and analysis, habitat condition assessments, ambient water quality sampling, and toxicity testing. Monitoring efforts have been conducted by agencies at both the state and local levels, including the Virginia Department of Environmental Quality (VADEQ), Occoquan Watershed Monitoring Laboratory (OWML), Fairfax County Stormwater Planning Division, Fairfax County Health Department, and the Upper Occoquan Sewage Treatment Authority (UOSA). In addition, two citizen monitoring groups, the Virginia Save Our Streams Program (VA SOS) and the Audubon Naturalist Society (ANS), have conducted monitoring efforts. **Figure 3-1** plots the location of all monitoring locations in the Bull Run watershed used for this analysis.

DRAFT

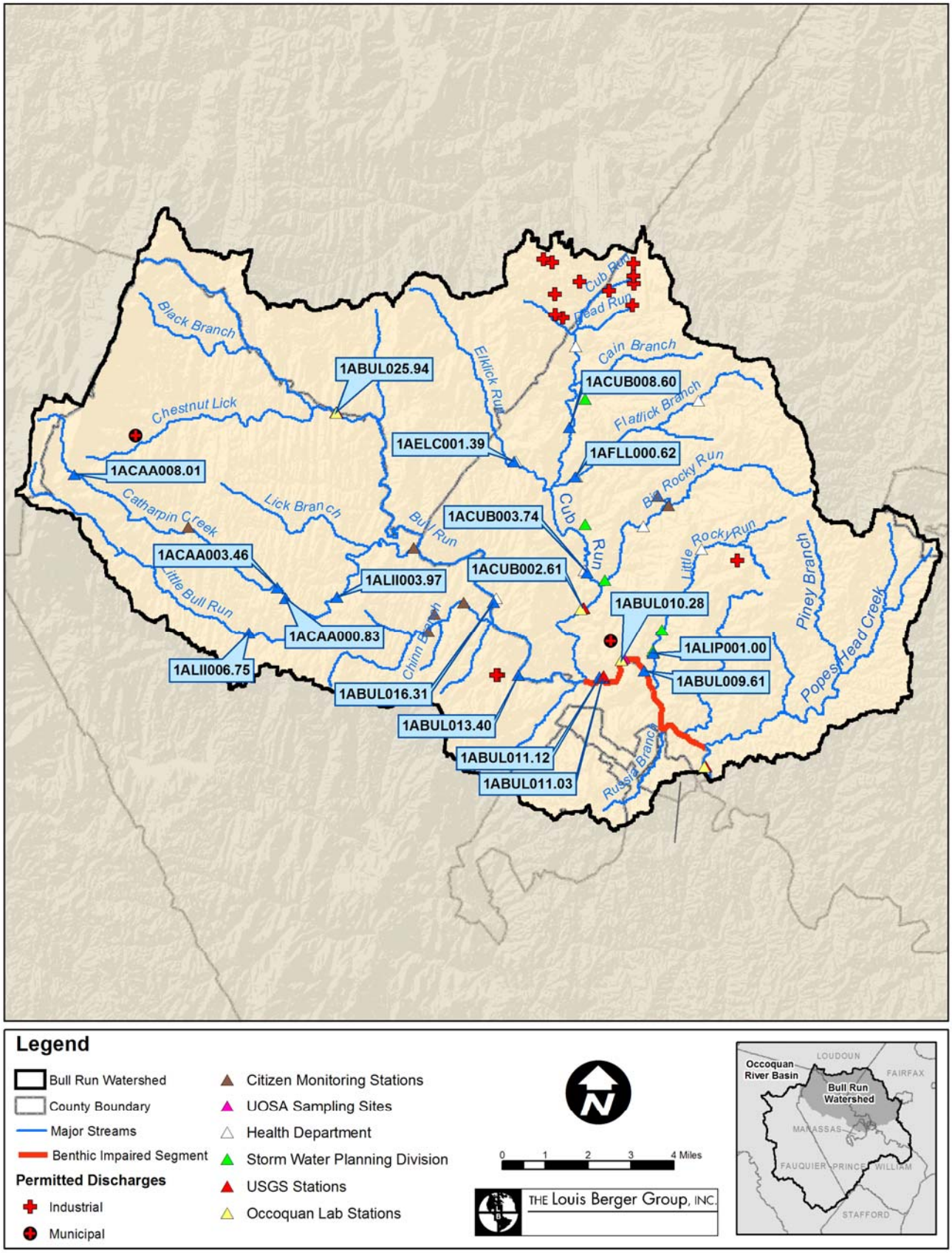


**Figure 3-1: Monitoring Locations in the Bull Run Watershed**

## 3.1 Virginia Department of Environmental Quality Data

The first step in benthic TMDL development is the identification of the pollutant stressor(s) that is impacting the benthic community. Environmental monitoring data are vital to this initial step. The following sections summarize and present the available monitoring data used to determine the primary stressor impacting the biologically impaired segment of Bull Run. Analyzed data included available biological and water quality monitoring data, Discharge Monitoring Reports (DMR) from the permitted facilities (*See Section 3.3*), and results from recent DEQ instream toxicity studies conducted on Bull Run. The collection period, content, and monitored sites for these data are summarized in **Table 3-1**. The locations of permitted discharge facilities and monitoring stations are presented in **Figure 3-1**.

**Table 3-1: Inventory of VDEQ Environmental Monitoring Data for Bull Run**

| Data Type | Collection Period | Monitoring Stations | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1ABLU009.61 | 1ABUL010.28 | 1ABUL011.03 | 1ABUL011.12 | 1ABUL013.40 | 1ABUL016.31 | 1ABUL025.94 | 1ACAA000.83 | 1ACAA003.46 | 1ACUB002.61 | 1ACUB003.74 | 1ACUB008.60 | 1ALII003.97 | 1ACAA003.46 | 1AFLL000.62 | 1AELC001.39 | 1ACCL006.75 | Permitted Facilities |
| Biological Monitoring | 1994-2005 | X | X | | X | | | | | | | | | | | | | | |
| Ambient Water Quality Monitoring | 1971-2005 | X | X | X | | | X | X | X | X | X | X | X | X | X | X | X | X | |
| Sediment Testing | 1979-2004 | X | X | | | X | | X | X | | X | X | | X | | X | | | |
| Fish Tissue Sampling | 1996-2004 | | X | | | X | | | | | | | | | | | | | |
| Toxicity Study | April 2004, May 2005 | | X | X | | | | | | | | | | | | | | | |
| Discharge Monitoring Reports (DMR) | 1999-2003 | | | | | | | | | | | | | | | | | | X |

### 3.1.1 Biological Monitoring Data

The impaired segment of Bull Run was included on Virginia's 1994 Section 303(d) List, and was subsequently included on Virginia's 1998 and 2002 Section 303(d) Lists of Impaired Waters and in the 2004 Water Quality Assessment 305(b)/303(d) Integrated

Report based on biomonitoring results obtained between 1994 and 2005. Biological monitoring data collected has been evaluated using two indicator metrics, the EPA's Rapid Bioassessment Protocol II (RBPII) and the Virginia Stream Condition Index (SCI).

***RBPII Scores***

A modified version of the EPA RBPII was used to assess the biological condition of the stream's benthic invertebrate communities. Candidate RBPII metrics, as specified in EPA's Rapid Bioassessment Protocols for Use in Streams and Wadable Rivers, Second Edition (Barbour et al., 1999), are presented in **Table 3-2**. Virginia DEQ bioassessments follow a paired reference approach using upstream stations located in the same watershed. The DEQ protocol uses eight standard metrics to compare monitored and reference sites. These metrics include taxa richness, composition, and tolerance/intolerance measures (**Table 3-2**). RBPII assessment ratings for the biomonitoring surveys conducted on Bull Run are presented in **Table 3-3**.

DEQ field data sheets and bioassessment forms completed for each biological assessment conducted on Bull Run contained the following information:

- Assessment ratings for each station for each survey event
- The numbers and types of macroinvertebrates present at each station
- Habitat assessment scores taken during each survey
- Field water quality data collected as part of each survey

DRAFT

**Table 3-2: Candidate RBPII Metrics Specified in Barbour et al. (2002)**

| Category | Metric | Definition | Response to Disturbance |
|---|---|---|---|
| **Richness Measures** | Total No. Taxa | Measures overall variety of invertebrate assemblage | Decrease |
| | No. EPT Taxa | Number of Ephemeroptera, Plecoptera, and Trichoptera taxa | Decrease |
| | No. Ephemeroptera Taxa | Number of mayfly taxa | Decrease |
| | No. Plecoptera Taxa | Number of stonefly taxa | Decrease |
| | No. Trichoptera Taxa | Number of caddisfly taxa | Decrease |
| **Composition Measures** | % EPT | Percent of the composite of mayfly, stonefly, and caddisfly larvae | Decrease |
| | % Ephemeroptera | Percent of mayfly nymphs | Decrease |
| **Tolerance/ Intolerance Measures** | No. Intolerant Taxa | Taxa richness of organisms considered to be sensitive to perturbation | Decrease |
| | % Tolerant Organisms | Percent of the macrobenthos considered to be tolerant of various types of perturbation | Increase |
| | % Dominant Taxon | Measures dominance of the most abundant taxon. Can be calculated as dominant 2, 3, 4, or 5 taxa | Increase |
| **Feeding Measures** | % Filterers | Percent of the macrobenthos that filter FPOM from water column or sediment | Variable |
| | % Grazers and Scrapers | Percent of macrobenthos that scrape or graze upon periphyton | Decrease |
| **Other Measures** | Hilsenhoff Biotic Index | Uses tolerance values to weight abundance in an estimate of overall pollution | Increase |

DRAFT

**Table 3-3: RBPII Assessment Ratings for Bull Run Biomonitoring Surveys**

| Time Period | Assessment Rating by Station | | | |
|---|---|---|---|---|
| | 1ABUL009.61 | 1ABUL010.28 | 1ABUL011.12 | 1ABUL025.94 |
| **Spring 1994** | - | Moderate Impairment | - | - |
| **Fall 1994** | - | Moderate Impairment | - | - |
| **Spring 1995** | - | Moderate Impairment | - | - |
| **Fall 1995** | - | Moderate Impairment | - | - |
| **Spring 1996** | - | Moderate Impairment | - | - |
| **Fall 1996** | - | Moderate Impairment | - | - |
| **Spring 1997** | - | Moderate Impairment | - | - |
| **Fall 1997** | - | Moderate Impairment | - | - |
| **Fall 1998** | - | Moderate Impairment | - | - |
| **Spring 1999** | - | Moderate Impairment | - | - |
| **Fall 1999** | - | Moderate Impairment | - | - |
| **Spring 2000** | - | Slight Impairment | - | - |
| **Spring 2004*** | - | Slight Impairment | - | - |
| **Fall 2004** | - | Moderate Impairment | - | No Impact |
| **Spring 2005** | Moderate Impairment | - | Slight Impairment | - |
| * Note 4 year time gap | | | | |

Biomonitoring surveys were conducted biannually at 1ABUL010.28 between from 1994 to 2000. During this period, the benthic community was listed as moderately impaired for 12 of 14 sampling events. Monitoring data was not collected on Bull Bun between 2000 and 2004.

In 2004, biomonitoring at station 1ABUL010.28 showed a slight impairment of the benthic community in the spring and a moderate impairment in the fall. In contrast,

DRAFT

during this same year, monitoring higher in the watershed at station 1ABUL025.94 showed that the biological community further upstream was not impaired.

Beginning in spring 2005, biomonitoring began at two new stations on Bull Run; station 1ABUL0009.61, which is just upstream of the confluence of Bull Run and Little Rocky Run, and station 1ABUL011.12, which is just below the confluence of Cub Run and Bull Run. Data from this most recent sampling event indicated that the upstream station 1ABUL011.12 was slightly impaired while the downstream station 1ABUL0009.6 was moderately impaired. Metrics calculated for the RBII scores at stations 1ABUL0009.61 and 1ABUL011.12 show distinct differences between these two stations for this sampling event. The metric for taxa richness, which measures the overall variety of invertebrate assemblage, was twice as high at 1ABUL011.12 in comparison to station 1ABUL0009.61. In addition, the percent of EPT taxa, which measures composition of mayfly, stonefly, and caddisfly larvae within the sample, was at 22.5% at 1ABUL011.12 while it was at 0.52% at 1ABUL0009.6. Since the majority of species of mayflies, stoneflies, and caddisflies are highly sensitive to pollution and environmental stress, this metric is used to determine the proportion of more sensitive species within the sample. The percent of dominance of the most abundant taxon within the sample was at 55% at station 1ABUL009.61 while this metric was at 22.6% at 1ABUL011.12. This indicates that only a few taxa dominate the sample at 1ABUL009.61 while at station 1ABUL011.12 there are a variety of taxa comprising the majority of the sample. Overall, these three metrics indicate that station 1ABUL009.61 had a less diverse and more tolerant benthic community than station 1ABUL011.12 during the 2004 sampling event. Although any observed differences are inconclusive from this one event, future sampling at these stations may provide insight into whether a difference between these two sites exists, and if so, what the potential stressors may be.

*SCI Scores*

Using the data collected during biomonitoring surveys, biological assessment scores were calculated using the SCI currently being developed by DEQ. The SCI is a regionally-calibrated index comprised of eight metrics that are listed in **Table 3-4**. The metrics used in calculation of an SCI score are similar to the metrics used in RBPII assessments.

DRAFT

However, unlike RBPII, the reference condition of the SCI is based on an aggregate of reference sites within the region, rather than a single paired reference site. Therefore, SCI scores provide a measure of stream biological integrity on a regional basis. An impairment cutoff score of 61.3 has been proposed for assessing results obtained with the SCI in the Occoquan watershed. Streams that score greater than 61.3 are considered to be non-impaired, whereas streams that score less than 61.3 are considered impaired.

Calculated SCI scores for the biomonitoring stations 1ABUL010.28, 1ABUL09.61, and 1ABUL11.12, all located on Bull Run between the confluence of Cub Run and Little Rocky Run, are presented in **Table 3-5**. Average SCI scores calculated for station 1ABUL010.28 between 1994 and 2004, and at Stations 1ABUL09.61 and 1ABUL09.61 in 2005 were below the proposed impairment cutoff score of 61.3; therefore, these stations the associated stream segment are considered to be impaired. Station 3RAP006.53, located on the Rapidan River, served as the reference station for the Bull Run biological assessments between 1994 and 2000, and throughout this period consistently showed scores well above the 61.3 benchmark. After 2000, however, stream conditions at station 3RAP006.53 began to decline, and as a result, the reference station for biological assessments conducted in 2004 and 2005 was changed to station 1AGOO022.44 on Goose Creek. SCI scores at this station have consistently been above the 61.3 aggregate SCI threshold value for the region.

DRAFT

**Table 3-4: Metrics Used to Calculate the Virginia Stream Condition Index (SCI)**

| Candidate Metrics (by categories) | Expected Response to Disturbance | Definition of Metric |
|---|---|---|
| ***Taxonomic Richness*** | | |
| Total Taxa | Decrease | Total number of taxa observed |
| EPT Taxa | Decrease | Total number of pollution sensitive Ephemoroptera, Plecoptera, and Trichoptera taxa observed |
| ***Taxonomic Composition*** | | |
| % EPT Less Hydropsychidae | Decrease | % EPT taxa in samples, subtracting pollution-tolerant Hydropsychidae |
| % Ephemoroptera | Decrease | % Ephemoroptera taxa present in sample |
| % Chironomidae | Increase | % pollution-tolerant Chironomidae present |
| ***Balance/Diversity*** | | |
| % Top 2 Dominant | Increase | % dominance of the 2 most abundant taxa |
| ***Tolerance*** | | |
| HBI (Family level) | Increase | Hilsenhoff Biotic Index |
| ***Trophic*** | | |
| % Scrapers | Decrease | % of scraper functional feeding group |

**Table 3-5: Virginia SCI Scores for Bull Run**

| Collection Period | SCI Score | | | | |
|---|---|---|---|---|---|
| | 1ABUL009.61 | 1ABUL010.28 | 1ABUL011.12 | 3RAP006.53[1] | 1AGOO022.44[2] |
| Spring 1994 | - | 56.9 | - | 76.7 | - |
| Fall 1994 | - | 55.6 | - | 68.9 | - |
| Spring 1995 | - | 62.0 | - | 76.3 | - |
| Fall 1995 | - | 54.6 | - | 74.0 | - |
| Spring 1996 | - | 42.1 | - | 74.7 | - |
| Fall 1996 | - | 55.8 | - | 75.7 | - |
| Spring 1997 | - | 59.9 | - | 71.9 | - |
| Fall 1997 | - | 50.8 | - | 78.1 | - |
| Spring 1998 | - | 63.0 | - | 71.0 | - |
| Fall 1998 | - | - | - | 70.2 | - |
| Spring 1999 | - | 48.3 | - | 72.6 | - |
| Fall 1999 | - | 48.8 | - | 69.0 | - |
| Spring 2000 | - | 42.9 | - | 71.8 | - |
| Fall 2000 | - | 60.5 | - | 70.8 | - |
| Spring 2004 | - | 40.2 | - | - | 67.6 |
| Fall 2004 | - | 57.2 | - | - | 62.6 |
| Spring 2005 | 36.57 | - | 56.83 | - | 67.5 |
| **Average** | **36.57** | **53.2** | **56.83** | **72.9** | **65.1** |

1: Monitoring station 3RAP006.53 served as the reference station from 1994-2000
2: Monitoring station 1AGOO022.44 served as the reference station for 2004

### 3.1.2 Habitat Assessment Scores

A suite of habitat variables were visually inspected at station 1ABUL010.28, and recently in 2005 at stations 1ABUL09.61 and 1ABUL11.12 as part of the biological assessments conducted on Bull Run. Habitat parameters that were examined include channel alteration, sediment deposition, substrate embeddedness, riffle frequency, channel flow and velocity, stream bank stability and vegetation, and riparian zone vegetation. Each parameter was assigned a score from 0 to 20, with 20 indicating optimal conditions, and 0 indicating very poor conditions. Habitat assessment scores for the three Bull Run biomonitoring stations and relevant reference stations are presented in **Table 3-6**.

Overall habitat assessment scores were generally lower at the impaired stations than at the reference stations. Specifically, scores for habitat metrics such as riparian zone vegetation, riffle frequency, and more recently, bank stabilization and protection were, on average, lower at the impaired stations than at the reference stations. Average assessment scores for other habitat metrics were similar between the reference and impaired stations.

DRAFT

**Table 3-6: Habitat Scores for Reference and Impaired Stations**

| Station ID | Date | Total Habitat Score | Channel Alteration | Bank Stability | Bank Vegetative Protection | Substrate Embeddedness | Channel Flow | Riffles | Riparian Zone | Sediment Deposition | Velocity Regime |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1ABUL010.28 | Fall 1994 | 113 | 15 | 14 | 12 | 8 | 16 | 6 | 12 | 12 | 10 |
| | Spring 1995 | 125 | 17 | 7 | 5 | 17 | 17 | 8 | 12 | 15 | 17 |
| | Fall 1995 | 164 | 16 | 17 | 16 | 16 | 17 | 17 | 14 | 16 | 18 |
| | Spring 1996 | 162 | 17 | 18 | 17 | 17 | 18 | 12 | 12 | 16 | 18 |
| | Fall 1995 | 149 | 17 | 15 | 16 | 12 | 18 | 12 | 12 | 14 | 17 |
| | Spring 1997 | 163 | 18 | 15 | 16 | 17 | 18 | 14 | 14 | 17 | 17 |
| | Fall 1997 | 168 | 18 | 18 | 17 | 16 | 19 | 14 | 15 | 17 | 18 |
| | Fall 1998 | 165 | 18 | 17 | 16 | 15 | 18 | 15 | 14 | 17 | 18 |
| | Spring 1999 | 163 | 18 | 17 | 17 | 15 | 18 | 12 | 16 | 17 | 18 |
| | Fall 1999 | 165 | 18 | 16 | 17 | 16 | 18 | 14 | 14 | 16 | 19 |
| | Spring 2000 | 149 | 17 | 16 | 18 | 12 | 20 | 10 | 16 | 11 | 14 |
| | Fall 2000 | 158 | 18 | 17 | 16 | 15 | 18 | 12 | 15 | 16 | 15 |
| | Spring 2004 | 149 | 20 | 12 | 12 | 17 | 15 | 15 | 10 | 12 | 18 |
| | Fall 2004 | 157 | 17 | 14 | 16 | 16 | 17 | 15 | 10 | 15 | 19 |
| | **AVG.** | **153.6** | **17.4** | **15.2** | **15.1** | **14.9** | **17.6** | **12.6** | **13.3** | **15.1** | **16.9** |
| 3RAP006.53 | Fall 1994 | 155 | 16 | 12 | 15 | 14 | 17 | 17 | 14 | 15 | 16 |
| | Spring 1995 | 164 | 16 | 16 | 16 | 14 | 17 | 16 | 18 | 16 | 16 |
| | Fall 1995 | 168 | 17 | 16 | 16 | 16 | 17 | 16 | 18 | 16 | 17 |
| | Spring 1996 | 180 | 18 | 17 | 19 | 17 | 19 | 16 | 20 | 17 | 18 |
| | Fall 1996 | 168 | 16 | 16 | 16 | 17 | 18 | 16 | 16 | 16 | 18 |
| | Spring 1997 | 173 | 17 | 17 | 17 | 17 | 18 | 16 | 18 | 17 | 18 |
| | Fall 1997 | 174 | 18 | 17 | 17 | 17 | 19 | 17 | 16 | 17 | 18 |
| | Fall 1998 | 175 | 18 | 16 | 17 | 18 | 19 | 16 | 17 | 17 | 19 |
| | Spring 1999 | 171 | 17 | 17 | 17 | 17 | 18 | 15 | 16 | 16 | 19 |
| | Fall 1999 | 165 | 12 | 17 | 18 | 14 | 20 | 15 | 15 | 16 | 20 |
| | Spring 2000 | 157 | 15 | 16 | 18 | 12 | 16 | 14 | 15 | 13 | 20 |
| | Fall 2000 | 151 | 14 | 16 | 16 | 11 | 18 | 14 | 12 | 14 | 18 |
| | **AVG.** | **166.8** | **16.2** | **16.1** | **16.8** | **15.3** | **18.0** | **15.7** | **16.3** | **15.8** | **18.1** |
| 1AGOO022.44 | Spring 2004 | 174 | 19 | 17 | 19 | 16 | 18 | 16 | 19 | 16 | 17 |
| | Fall 2004 | 176 | 20 | 18 | 18 | 16 | 18 | 16 | 19 | 15 | 19 |
| | **AVG.** | **175** | **19.5** | **17.5** | **18.5** | **16** | **18** | **16** | **19** | **15.5** | **18** |
| 1ABUL009.61 | Spring 2005 | 158 | 18 | 12 | 18 | 13 | 18 | 14 | 20 | 12 | 19 |
| 1ABUL011.12 | Spring 2005 | 153 | 19 | 16 | 18 | 14 | 14 | 11 | 20 | 13 | 15 |

DRAFT

## 3.1.3 Ambient Water Quality Monitoring

There are 40 active and historic DEQ ambient water quality monitoring stations located in the Bull Run watershed (**Table 3-7**). Of these 40 stations, 16 have monitoring data within the last 10 years[1]. Monitoring data from 1 of these 16 stations, station 1APOE002.00 on Popes Head Creek, is removed from consideration within this analysis because: 1) Popes Head Creek provides input to Bull Run below the 303d listed segment, and 2) information from this station is currently being analyzed in a separate TMDL for Popes Head Creek. The remaining 15 water quality stations in the watershed represent the most recent DEQ water quality monitoring data available for the Bull Run watershed, and are therefore used in this analysis **(Table 3-7).**

**Table 3-7: Ambient Water Quality Monitoring Stations Located in the Bull Run Watershed**

| Station ID[1] | Stream Name | Station Description | First Sample Date | Last Sample Date | Number of Samples |
|---|---|---|---|---|---|
| 1ABIR000.76 | Big Rocky Run | Intersection with Route 29/211 | 1974 | 1979 | 566 |
| 1ABIR005.21 | Big Rocky Run | Intersection with Route 645 | 1976 | 1982 | 49 |
| 1ABUL009.61* | Bull Run | Downstream from Route 28 | 2005 | 2005 | 153 |
| 1ABUL010.28* | Bull Run | Intersection with Route 28 | 1978 | 2005 | 5386 |
| 1ABUL011.03* | Bull Run | Intersection with Route 616 (Old Centreville Rd) | 1971 | 1999 | 846 |
| 1ABUL016.31* | Bull Run | Intersection with Route 29/211 | 1975 | 2005 | 52 |
| 1ABUL025.94* | Bull Run | Intersection with Route 705 | 1976 | 2005 | 1735 |
| 1ACAA000.83* | Catharpin Creek | Intersection with Route (~0.35 Miles below) | 2003 | 2003 | 129 |
| 1ACAA003.46* | Catharpin Creek | Intersection with Route 676 | 1975 | 2005 | 84 |
| 1ACAA008.01 | Catharpin Creek | Intersection with Route 600 | 1975 | 1994 | 75 |
| 1ACUB002.61* | Cub Run | Intersection with Route 658 (Compton Rd) | 2001 | 2005 | 477 |
| 1ACUB003.74* | Cub Run | Intersection with Route 29/211 | 1974 | 2001 | 2017 |
| 1ACUB008.60* | Cub Run | Intersection with Route 661 (Old Lee Highway) | 1976 | 2003 | 281 |
| 1ACUB011.25 | Cub Run | Intersection with Route 50 | 1976 | 1982 | 32 |
| 1AELC001.39* | Elklick Run | Intersection with Route 609 (Pleasant Valley Rd) | 2001 | 2005 | 303 |
| 1AFLB000.64 | Flat Branch | Intersection with Route 1501 | 1974 | 1979 | 307 |
| 1AFLB001.40 | Flat Branch | Intersection with Route 1530 | 1974 | 1979 | 231 |
| 1AFLB002.53 | Flat Branch | Intersection with Route 234 | 1977 | 1983 | 38 |

[1] To be inclusive and to allow for processing delays in the most recent water quality monitoring data, "the last 10 years" includes data from 1994 to the present day, in this case 1994 – 2005.

| Station ID[1] | Stream Name | Station Description | First Sample Date | Last Sample Date | Number of Samples |
|---|---|---|---|---|---|
| 1AFLL000.62* | Flatlick Branch | Between Route 609 and Route 620 | 2001 | 2001 | 64 |
| 1AFLL000.88 | Flatlick Branch | Intersection with Route 620 | 1976 | 1982 | 48 |
| 1AFLL001.98 | Flatlick Branch | Intersection with Route 28 | 1977 | 1977 | 16 |
| 1AFLL002.76 | Flatlick Branch | Intersection with Route 657 | 1977 | 1977 | 17 |
| 1AFLL004.37 | Flatlick Branch | Intersection with Route 645 | 1977 | 1977 | 16 |
| 1AJOH002.42 | Johnny Moore Creek | Intersection with Route 658 | 1976 | 1989 | 53 |
| 1AJOH004.08 | Johnny Moore Creek | Intersection with Route 3546 | 1989 | 1989 | 33 |
| 1AJOH005.04 | Johnny Moore Creek | Intersection with Route 645 | 1989 | 1989 | 33 |
| 1ALID002.60 | Little Difficult Run | Intersection with Route 669 | 1976 | 1980 | 30 |
| 1ALII000.14 | Little Bull Run | Intersection with Route 234 | 1975 | 1976 | 34 |
| 1ALII003.97* | Little Bull Run | Intersection with Route 705 | 1976 | 2005 | 1468 |
| 1ALII006.75* | Little Bull Run | Intersection with Route 676 | 2005 | 2005 | 21 |
| 1ALIP001.00* | Little Rocky Run | Intersection with Route 658 (Compton Rd.) | 2003 | 2005 | 77 |
| 1APIY000.05 | Piney Branch | Intersection with Route 660 | 1977 | 1977 | 17 |
| 1APIY002.72 | Piney Branch | Intersection with Route 620 | 1977 | 1977 | 17 |
| 1APOE001.55 | Pope's Head Creek | Intersection with Route 659 | 1977 | 1988 | 35 |
| 1APOE002.00[2] | Pope's Head Creek | Intersection with Route 645 (Clifton Rd.) | 1990 | 2005 | 1923 |
| 1APOE005.40 | Pope's Head Creek | Intersection with Route 660 | 1977 | 1988 | 34 |
| 1APOE007.20 | Pope's Head Creek | Intersection with Route 654 | 1988 | 1988 | 17 |
| 1APOE008.36 | Pope's Head Creek | Intersection with Route 620 | 1977 | 1988 | 34 |
| 1AXAC000.09 | Tributary to Flat Branch | Intersection with Route 1501 | 1976 | 1983 | 64 |
| 1AXGB000.07 | Tributary to Flat Branch | Intersection with Route 1530 | 1976 | 1983 | 36 |

*Stations represented the most recent data sources within the watershed and were therefore used for analysis.

[1]Note: The last 5 digits of the DEQ station number corresponds to stream mile.

[2] Data collected at1APOE002.00 is currently being addressed in a separate TMDL.

Streams within the Bull Run watershed are classified as Class III waterbodies (Nontidal Waters), as defined in Virginia Water Quality Standards (9 VAC 25-260-50). Thus, water quality parameters in the impaired segment must meet the Class III standards (**Table 3-8**).

DRAFT

**Table 3-8: Virginia Water Quality Standards for streams in the Bull Run Watershed**

| Class | Description of Waters | Dissolved Oxygen (mg/L) | | pH | Maximum Temperature (Deg. C) |
|---|---|---|---|---|---|
| | | Minimum | Daily Average | | |
| III | Nontidal Waters | 4.0 | 5.0 | 6.0-9.0 | 32 |

Of the monitoring stations in the watershed with data in the last decade, 6 are located on Bull Run, and 4 of these have been sampled more than once between 1994 and 2005. Data collected at these four stations, 1ABUL009.61, 1ABUL010.28, 1ABUL016.13, and 1ABUL025.94 between 1994 to 2005 are presented in **Figures 3-2** to **3-12**. A bulleted summary of the data derived from all monitoring data collected on the Bull Run mainstem is listed below:

- Field dissolved oxygen data presented in **Figure 3-2** indicates that, in general, adequate DO levels are found in the Bull Run watershed.
- The DO diurnal study conducted between August 3 and August 5, 2005 (**Figure 3-3**) shows DO levels above the minimum standard with normal diurnal swings of 2 mg/L (or ~30% of saturation).
- Field pH and temperature values have been in compliance with numeric criteria for Class III waters (**Figures 3-4, 3-5**).
- Conductivity levels measured were low at 1ABUL025.94 but were higher at station 1ABUL010.28 and 1ABUL009.61 (**Figure 3-6**).
- Biochemical oxygen demand concentrations are generally low across all stations (**Figure 3-7**).
- Suspended solids concentrations were variable; observed concentrations were low for most sampling events, but elevated suspended solids concentrations were observed in some instances (**Figure 3-8**).
- Nitrate concentrations were low at station 1ABUL025.94, but were very high (10-15 mg/L) at station 1ABUL010.28 (**Figure 3-9**). This shift in nitrate concentration along the length of Bull Run is likely attributed to the Upper Occoquan Sewer Authority (UOSA) treatment plant, which is located below

DRAFT

station 1ABUL025.94 but above station 1ABUL010.28, and does not have a permitted discharge limit for nitrate.

- Ammonia and total phosphorus concentrations were generally low across all sampling events (**Figures 3-10, 3-11**).
- Several violations of the Virginia fecal coliform instantaneous standard occurred at the monitoring stations (**Figure 3-12**). A bacteria TMDL is currently being developed for Bull Run and will be presented in a separate report.

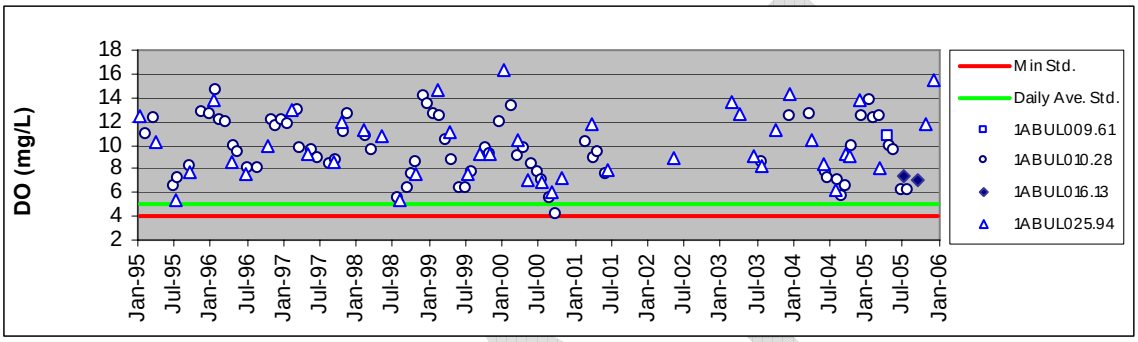


**Figure 3-2: Bull Run Field Dissolved Oxygen Concentrations**

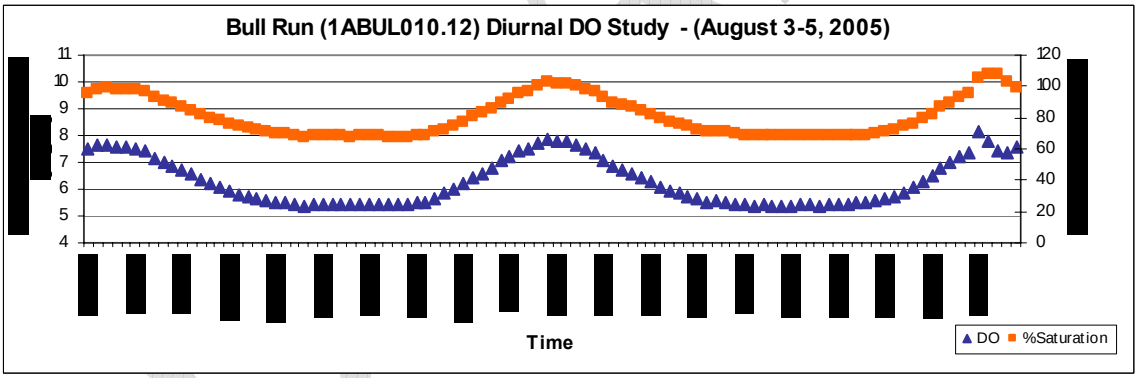


**Figure 3-3: Bull Run Diurnal DO Concentrations**

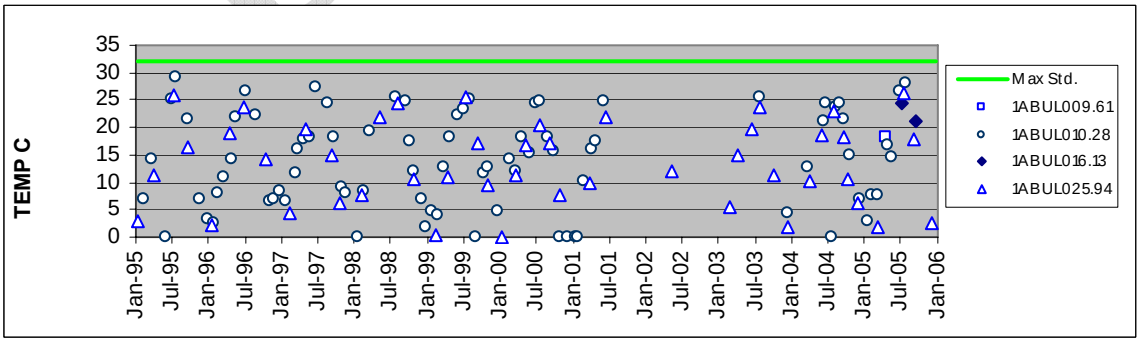


**Figure 3-4: Bull Run Temperature Values**

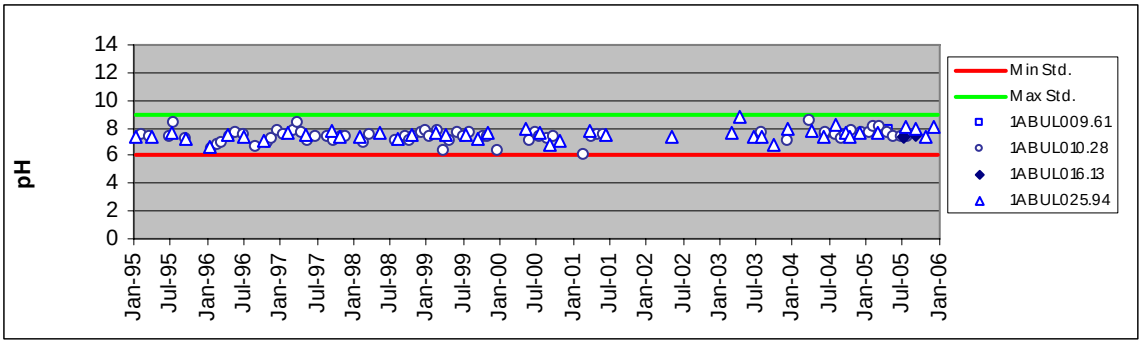


**Figure 3-5: Bull Run Field pH Data**

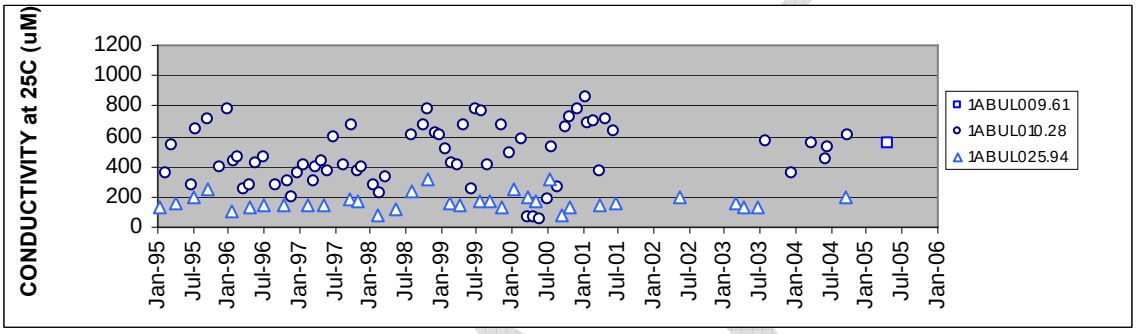


**Figure 3-6: Bull Run Conductivity Data**

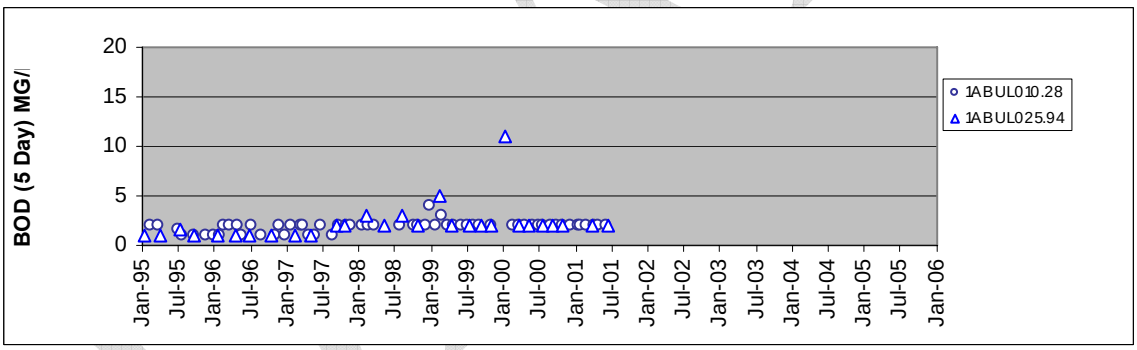


**Figure 3-7: Bull Run Biochemical Oxygen Demand Concentrations**

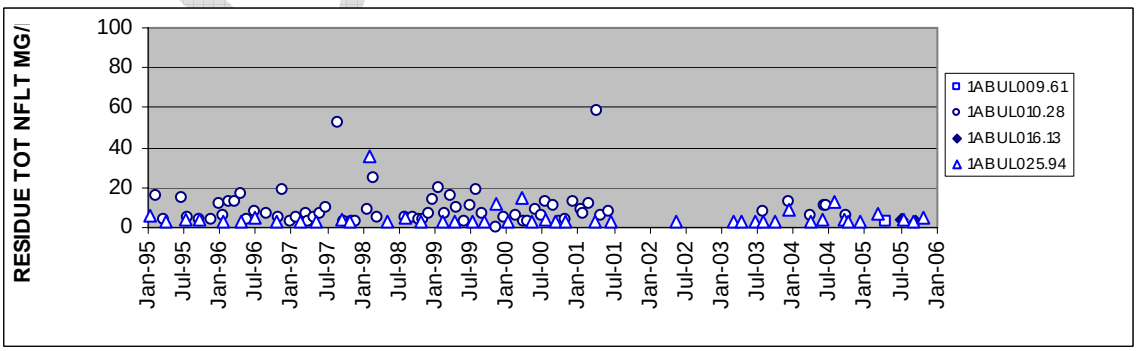


**Figure 3-8: Bull Run Total Residue Concentrations**

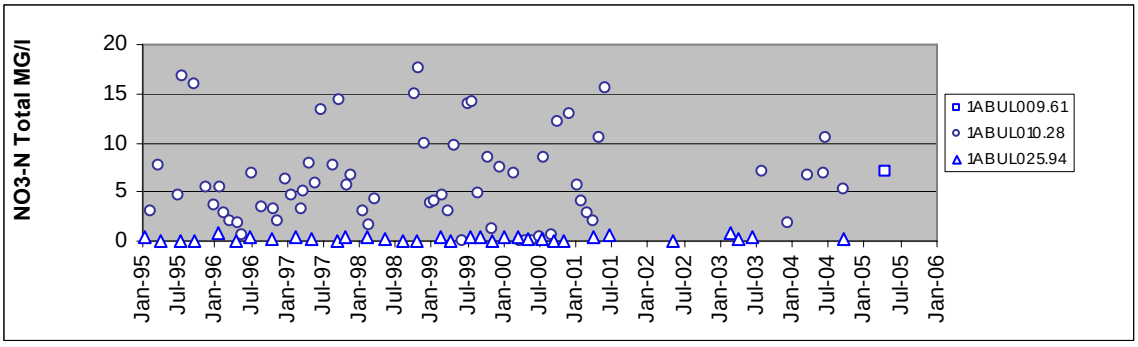


**Figure 3-9: Bull Run Nitrate Concentrations**

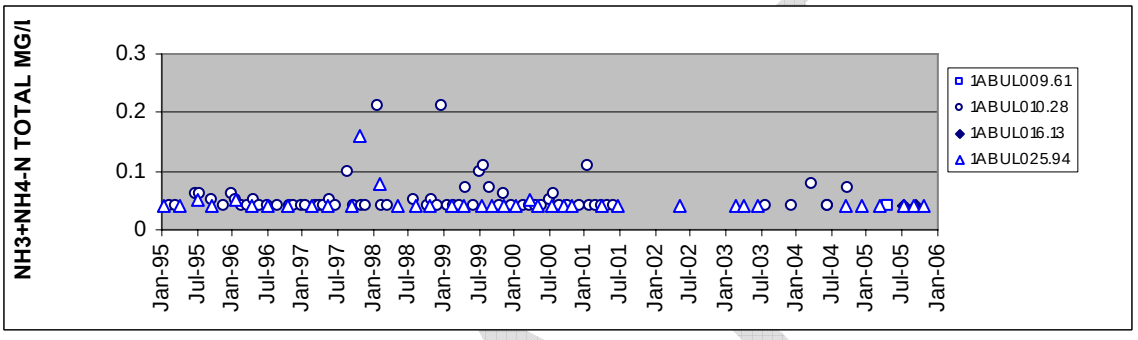


**Figure 3-10: Bull Run Ammonia Concentrations**

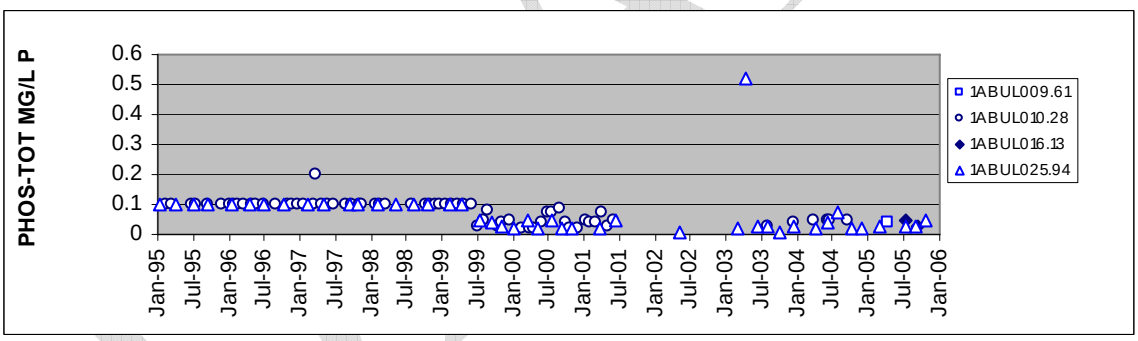


**Figure 3-11: Bull Run Total Phosphorus Concentrations**

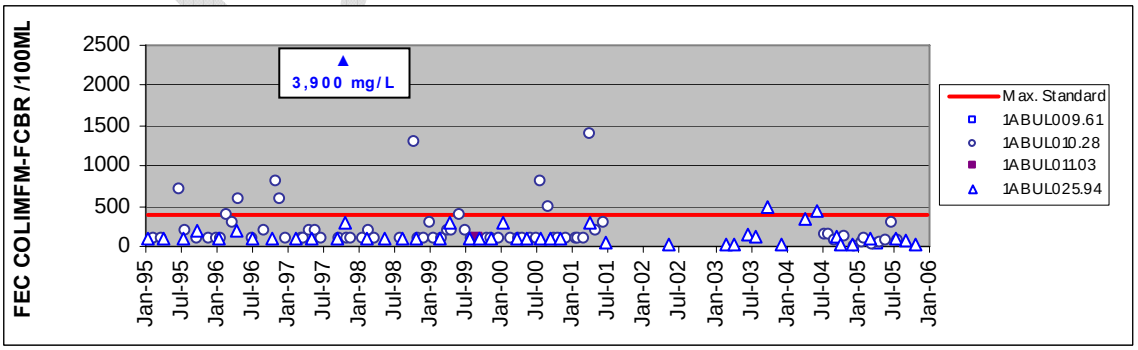


**Figure 3-12: Bull Run Fecal Coliform Concentrations**

Ambient water quality monitoring data for the 10 stations located on tributaries that provide input to Bull Run above the listed segment was also analyzed. Monitoring data from these stations shows that in general, ambient water quality parameters were observed within ranges similar to that observed on the Bull Run mainstem with some notable observations.

- Field dissolved oxygen levels exceeded the minimum daily average minimum for two stations on Cub Run in August of 1998 (ACUB003.74) and in June of 2003 (ACUB008.60).
- Several violations of the Virginia fecal coliform instantaneous standard occurred at monitoring stations on Cub Run, Little Bull Run, and Elklick Run. A bacteria TMDL is currently being developed for Bull Run and will be presented in a separate report.

### 3.1.3 Metals Data

Disssolved metals parameters were examined at stations 1ABUL010.28, 1ABUL011.03, 1ABUL025.94, and 1ACAA008.01 in the Bull Run watershed. Metals measured included arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, and zinc. All available dissolved metals data collected were analyzed to determine whether the examined parameters complied with Virginia's established water quality standards. No monitored metals parameters violated the acute or chronic dissolved freshwater criteria specified in Virginia's aquatic life use standards for dissolved metals. Almost all metals parameters analyzed were below analytical detection limits.

Additionally, although there are currently no water quality standards established for sediment metals, the 2004 DEQ assessment guidance memorandum (DEQ, 2004) establishes consensus based Probable Effects Concentrations (PEC) ($99^{th}$ percentile of results throughout Virginia) for use in determining aquatic life use support. Sediment metals data collected in the Bull Run watershed were analyzed to determine whether they complied with the consensus based screening values. Though many compounds were noted in sediment testing, none exceeded the thresholds for the PEC.

DRAFT

Fish tissue sampling was also conducted in 2001 and 2004 and analyzed for metals. Results from these tests did not show any exceedences of the risk-based Tissue Screening Value for metals.

### 3.1.4 Organics Data

Organics data collected in the Bull Run watershed include dissolved (stations 1ABUL010.28 and 1ABUL025.94) and sediment samples (stations 1ABUL025.94, 1ABUL010.28, 1ABUL009.61, 1ABUL000.62, 1ACAA000.83, 1ALLII003.97, and 1ACUB003.74) analyzed for aldrin, dieldrin, endosulfan, endrin, dichlorodiphenyldichloroethane (DDD), dichlorodiphenyldichloroethylene (DDE), dichlorodiphenyltrichloroethane (DDT), polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs).

All available organics data collected in the Bull Run watershed were analyzed to determine whether the examined parameters complied with Virginia's established water quality standards and sediment screening values. Based on the available data, no violations of the acute or chronic dissolved freshwater criteria were observed, and the majority of dissolved organic parameters measured fell below detection limits. In contrast, although many of the available sediment organics data were also below detection limits, sediment PAH (sediment non-halogenated organics) samples at station 1ABUL013.40 were recorded as exceeding the screening criteria for dibenz [A,H]anthracene in 2004 (using the 99$^{th}$ percentile for statewide data). In addition, although monitored levels were below the consensus based sediment screening values specified in the DEQ 2004 assessment guidance memorandum, the presence of several PAH compounds at station 1ABUL010.28 were also noted (chrysene, pyrene, and fluoranthene).

Results from fish tissue data collected in 2001 and 2004 revealed exceedances of the water quality criterion based tissue value (TV) of 54 parts per billion for polychlorinated biphenyls (PCBs). In 2001, at station 1ABUL010.28 fish tissue samples not only revealed exceedences of the TV criterion for PCBs and but also the risk-based tissue-screening values (TSI) of 10 ppb for heptachlor epoxide. In 2004, exceedence of the TV

DRAFT

criterion of PCBs were found in flathead catfish samples from 1ACUB002.61 and channel catfish samples from 1ABUL010.28.

### 3.1.5 Toxicity Testing

Toxicity testing was performed on water samples collected on Bull Run by DEQ on April 12th, 14th, and 16th, 2004 at stations 1ABUL010.28 and 1ABUL011.03. The EPA Region 3 laboratory in Wheeling, West Virginia performed chronic toxicity testing on samples using fathead minnows and *Ceriodaphnia dubia* as test organisms. Results indicated *Ceriodaphnia* mortality and reproduction in the Bull Run water samples were not statistically different than mortality and reproduction in the control samples, thus indicating that there were no toxic water column effects to *Ceriodaphnia* in the Bull Run samples.

Fathead minnow growth in the Bull Run water samples was not statistically different from growth in the control samples. Fathead minnow survival in samples collected at station 1ABUL011.03 was also not statistically different than survival in the control samples. However, fathead minnow survival in samples collected at station 1ABUL010.28 was 65%, which was statistically different from the laboratory control. The EPA Region 3 laboratory in Wheeling indicated that in their professional judgment, this result "was probably biologically significant", and that it was necessary to compare the observed toxicity testing results with other water quality data collected at this site to determine the presence of toxicity.

Additional samples were collected for toxicity testing by DEQ at stations 1ABUL010.28 and 1ABUL011.03 on May 2nd – 6th, 2005. Results from samples collected in May 2005 also indicated *Ceriodaphnia* and fathead minnow mortality and reproduction in the Bull Run water samples were not statistically different than mortality and reproduction in the control samples, thus indicating that there were no toxic water column effects to either *Ceriodaphnia* or fathead minnows.

DRAFT

## 3.2 Supplemental Water Quality Monitoring Data

### 3.2.1 Occoquan Watershed Monitoring Lab

The Occoquan Watershed Monitoring Laboratory (OWML) has conducted water quality monitoring efforts throughout the Occoquan River Basin since its establishment in 1972 by the Virginia Polytechnic Institute Department of Civil Engineering. **Table 3-9** lists the OWML stations found in the watershed, the type of monitoring conducted, the period of record, and the number of sampling events conducted.

**Table 3-9: OWML Sampling in the Bull Run Watershed**

| Site ID | Location | Data Type | Sampling Period | Number of Sampling Events |
|---|---|---|---|---|
| ST45 | Bull Run, below Cub Run confluence | Ambient | January 1994- September 2004 | 726 |
| | | Flow | January 1994-December 2004 | 4018 |
| ST50 | Bull Run above Cub Run confluence | Ambient | January 1994- September 2004 | 672 |
| | | Flow | January 1994- September 2004 | 3904 |
| ST60 | Bull Run below Chestnut Lick | Flow | January 1994- September 2004 | 3978 |

*Data Summary:*

Instream water quality data collected at stations ST45 and ST50 shows that pH, temperature, and DO values have been in compliance with numeric criteria for Class III waters. Suspended solids concentrations were variable (Min: 0.5 mg/L, Max: 1220 mg/L, Avg.: 65 mg/L) observed concentrations were low for most sampling events, but elevated suspended solids concentrations were observed in some instances. Ammonia (Min: 0.005 mg/L, Max: 1.00 mg/L, Avg.: 0.05 mg/L) and total phosphorus (Min: 0.005 mg/L, Max: 0.92 mg/L, Avg.: 0.11 mg/L) concentrations were generally low across all sampling events. In addition, no monitored dissolved organics parameters violated acute or chronic

DRAFT

dissolved freshwater criteria specified in Virginia's water quality standards[2]. However, on January 12, 1998 the sample collected exceeded the Virginia's human health standards for all surface waters other than those used for public water supply for the following parameters: benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene and pyrene Indeno(1,2,3-cd)pyrene.

### 3.2.2 Fairfax County Stormwater Planning Division

In 1999, the Fairfax County Stormwater Planning Division (SPD) prepared a Stream Protection Strategy Baseline Study that was designed to support the development of biological indicators of stream quality. The SPD collected detailed biological and habitat condition information on 138 stream reaches in the county. Each reach was assigned a qualitative ranking overall stream quality, either Excellent, Good, Fair, Poor, or Very Poor. Additional biological monitoring data was also collected in 2001. The stream reaches sampled in the Bull Run watershed for this study are presented in **Table 3-10**. Note, qualitative rankings of habitat and biotic community condition were only provided for the 1999 sampling effort.

DRAFT

[2] It should be noted that only 20 of the 53 organics parameters tested by OWML currently do not have Virginia State water quality standards.

**Table 3-10: Fairfax County Stormwater Site Condition Assessments**

| Site ID | Stream Name | Type/ Freq. | Date | SCI Score Below Regional Standard ? (Y/N) | Site Condition Ranking | Index of Biotic Integrity | Habitat Score | Fish Taxa Richness |
|---|---|---|---|---|---|---|---|---|
| CUSB 01 | Cub Run | Biological/ Yearly | 2001 | Y | N/A | N/A | N/A | N/A |
| CURL 01 | Cub Run | Biological/ Yearly | 2001 | Y | N/A | N/A | N/A | N/A |
| CUBR 02 | Big Rocky Run | Biological/ Yearly | 1999 | Y | Fair | Fair | Fair | Moderate |
| | | | 2001 | Y | N/A | N/A | N/A | N/A |
| LRLR 03 | Little Rocky Run | Biological/ Yearly | 1999 | Y | Fair | Poor | Good | Moderate |
| | | | 2001 | Y | N/A | N/A | N/A | N/A |
| LRLR 04 | Little Rocky Run | Biological/ Yearly | 2001 | Y | N/A | N/A | N/A | N/A |

### 3.2.3 Fairfax County Health Department, Division of Environmental Health

The Fairfax County Health Department's mission is to protect and improve the health of Fairfax County citizens by preventing or eliminating their exposure to biological, chemical and physical hazards in their present or future environment. As part of this mission, the Division of Environmental Health monitors chemical and biologic (bacteria) water quality parameters regularly throughout Fairfax County. The Division of Health has monitored water quality parameters at 11 sites in the watershed, the majority of which have records dating back to 1986. **Table 3-11** lists the Division of Health stations in the Bull Run watershed with the type of monitoring, the period of record, and number of sampling events conducted.

DRAFT

**Table 3-11: Fairfax County Health Department Sampling in the Bull Run Watershed**

| STA. ID | Stream Sampled | Parameters Sampled | Date Range | Number of Observations |
|---|---|---|---|---|
| 27-01 | Johnny More Creek | Chemical (Temp, pH, $N0_3$-N, $PO_4$-P, dissolved oxygen) | January 1986-August 2002 | 330 |
| | | Bacteria (Fecal Coliform) | January 1986-December 2002 | 331 |
| 28-01 | Little Rocky Run | Chemical | January 1986-August 2002 | 346 |
| | | Bacteria | January 1986-December 2002 | 349 |
| 28-02 | Little Rocky Run | Chemical | January 1986-September 2002 | 337 |
| | | Bacteria | January 1986-December 2002 | 338 |
| 29-02 | Big Rocky Run | Chemical | January 1986-August 2002 | 350 |
| | | Bacteria | January 1986-December 2002 | 353 |
| 29-03 | Cub Run | Chemical | January 1986-August 2002 | 351 |
| | | Bacteria | January 1986-December 2002 | 354 |
| 29-04 | Cub Run | Chemical | January 1986-September 2002 | 346 |
| | | Bacteria | January 1986-December 2002 | 347 |
| 29-05 | Fatlick Branch | Chemical | January 1986-August 2002 | 341 |
| | | Bacteria | January 1986-December 2002 | 347 |
| 29-06 | Fatlick Branch | Chemical | January 1986-September 2002 | 350 |
| | | Bacteria | January 1986-December 2002 | 354 |
| 29-07 | Elklick Branch | Chemical | February 2000-August 2002 | 51 |
| | | Bacteria | January 2000-December 2002 | 53 |
| 29-08 | Cub Run | Chemical | January 1986-August 2002 | 351 |
| | | Bacteria | January 1986-December 2002 | 351 |
| 29-09 | Cub Run | Chemical | January 2001-August 2002 | 50 |
| | | Bacteria | January 2000-December 2002 | 50 |
| 30-01 | Bull Run | Chemical | January 1986-August 2002 | 175 |
| | | Bacteria | January 1986-December 2002 | 357 |

*Data Summary:*

Instream water quality data collected at the 14 stations within the watershed all show that pH and temperature values have been in compliance with numeric criteria for Class III waters. In addition, nitrogen (Min: 0.01 mg/L, Max: 9.3 mg/L, Avg.: 0.67 mg/L) and phosphorous (Min: 0.01 mg/L, Max: 1.07 mg/L, Avg.: 0.12 mg/L) concentrations were generally low at all stations. However, dissolved oxygen levels were observed to violate the instantaneous standard at least once at 9 of the 11 stations (Min: 1.8 mg/L, Max: 26.3 mg/L, Avg.: 8.84 mg/L). The following table, **Table 3-12**, lists the observed DO instantaneous oxygen violations at the 11 Health Department Stations.

**Table 3-12: Fairfax County Health Department Dissolved Oxygen Violations**

| Station ID | Year Sampled | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
| 27-01 | | | | | | | | |
| 28-01 | X | | | X | | X | X | X |
| 28-02 | X | | | | | | | |
| 29-02 | | | | | | | | |
| 29-03 | X | | | | | | | X |
| 29-04 | X | | | | | | | |
| 29-05 | X | | | | | | | |
| 29-06 | X | | | X | | | | |
| 29-07 | | | | | | | X | X |
| 29-08 | X | | | | | X | | |
| 29-09 | | | | | | X | | |
| 30-01 | X | | | X | | | | |

X= Violation of the instantaneous dissolved oxygen minimum standard for Class III waters

### 3.2.4 Upper Occoquan Sewage Authority Ambient Water Quality Data

The Upper Occoquan Sewage Authority (UOSA) is the largest permitted discharger in the Bull Run Watershed. In addition to its discharge monitoring requirements, UOSA also monitors instream water quality on Bull Run upstream from its discharge at Old Centreville Road (OCR) and downstream of its discharge at Route 28. Sample data from January 2004 to September 2005 was provided by UOSA for this study, and inventory of this data is presented in **Table 3-13**.

**Table 3-13: UOSA Ambient Water Quality Data**

| Site ID | Location on Bull Run | Data Type/ Frequency | Sampling Peroid | Number of Sampling Events |
|---|---|---|---|---|
| OCR | Old Centreville Road | Ambient/ Monthly | January 2004-September 2005 | 18 |
| Route 28 | Route 28 | Ambient/ Monthly | January 2004-September 2006 | 18 |

*Data Summary:*

The data collected by USOA consists of ambient monthly observations of dissolved oxygen, temperature, pH, chemical oxygen demand (COD), E-coli, hardness, total

suspended sediments, and nutrients (ammonia, nitrate, nitrite, TKN, total phosphorus, and total nitrogen concentrations). At both stations, temperature and pH complied with the VADEQ water quality standards. Dissolved oxygen concentrations (Min: 3.2 mg/L, Max: 11.8 mg/L, Avg.: 6.55 mg/L) twice violated the instantaneous water quality standard at the Route 28 station over the 18 month period (3.9 and 3.2 mg/L). Although nitrate levels increased downstream of the USOA discharge, nitrate concentrations remained relatively low (Min: 0.07 mg/L, Max: 19.10 mg/L, Avg.: 3.3 mg/L). All other nutrient concentrations as well as the level of total dissolved solids remained relatively low at both stations.

### 3.2.5 Citizen Monitoring Groups

Biological and habitat monitoring data was collected within the Bull Run Watershed by two citizen monitoring groups, the Virginia Save Our Streams Program (VA SOS) and the Audubon Naturalist Society (ANS). In 2001, VA SOS began using a modified method of the traditional Save Our Streams monitoring method. This resulted in changes to the collection and identification procedures that yields results comparable to data collected using professional methods (Engel and Voshell, 2002). A summary of the SOS data collected using this modified method is presented in **Table 3-14**. ANS uses a modified version of the U. S. Environmental Protection Agency (EPA) Rapid Bioassessment II Protocol for macroinvertebrate collection and habitat assessment. Results obtained using the ANS methods are also used by DEQ for water quality assessments. A summary of ANS data is shown in **Table 3-15**.

**Table 3-14: SOS Biological Monitoring Data**

| Station # | Stream | DEQ Station ID | Total Monitoring Events * | # Rated Unacceptable * | Dates | Type |
|---|---|---|---|---|---|---|
| CR5 | Big Rocky Run | 1ABIR-CR5-SOS | 3 | 2 | 4/2001, 2/2002, 4/2002 | Biological, Habitat |
| CR1 | Cub Run | 1ACUB-CR1-SOS | 3 | 1 | 4/2001, 2/2002, 4/2002 | Biological, Habitat |
| CR3 | Cub Run | 1ACUB-CR3-SOS | 3 | 0 | 4/2001, 4/2002, 7/2002 | Biological, Habitat |

DRAFT

| Station # | Stream | DEQ Station ID | Total Monitoring Events * | # Rated Unacceptable * | Dates | Type |
|---|---|---|---|---|---|---|
| CR6 | Cub Run | 1ACUB-CR6-SOS | 3 | 1 | 4/2001, 2/2002, 4/2002 | Biological, Habitat |
| JMC1 | Johnny Moore Creek | 1AJOH-JMC1-SOS | 2 | 0 | 3/2001, 1/2002 | Biological, Habitat |
| JMC2 | Johnny Moore Creek | 1AJOH-JMC2-SOS | 1 | 1 | 4/2001 | Biological, Habitat |
| JMC3 | Johnny Moore Creek | 1AJOH-JMC3-SOS | 1 | 0 | 4/2002 | Biological, Habitat |
| JMC4 | Johnny Moore Creek | 1AJOH-JMC4-SOS | 3 | 0 | 4/2001, 8/2001, 1/2002 | Biological, Habitat |
| PIM1 | Little Pimmit Run | 1ALIO-PIM1-SOS | 2 | 2 | 4/2001, 8/2001 | Biological, Habitat |

* Modified method

**Table 3-15: ANS Biological Monitoring Data**

| Station # | DEQ Site Number | Stream Name | Type | No. of Monitoring Events | Date | Quality Rating |
|---|---|---|---|---|---|---|
| 4 | 1AYOU-4-ANS | Young's Branch | Biological, Habitat | 4 | 1998-1999 | Fair |
| 5 | 1AYOU-5-ANS | Young's Branch | Biological, Habitat | 16 | 1998-2002 | Fair (borderline with good) |
| 7 | 1ACAA-7-ANS | Catharpin Creek | Biological, Habitat | 18 | 1998-2002 | Good |
| 9 | 1AWAL*-9-ANS | Walney Creek (unnamed trib to Big Rocky Run) | Biological, Habitat | 17 | 1998-2002 | Excellent |
| 10 | 1ABIR-10-ANS | Big Rocky Run | Biological, Habitat | 18 | 1998-2002 | Poor (borderline with fair) |
| 13 | 1ALII-13-ANS | Little Bull Run | Biological, Habitat | 11 | 1998-2002 | Good |
| 15 | 1AYOU-15-ANS | Young's Branch | Biological, Habitat | 15 | 1999-2002 | Fair |

* "Overall Stream Quality Rating" - Cumulative rating based on all monitoring events

*Data summary*

Five out of the nine stations where VA SOS conducted biomonitoring efforts received at least one unacceptable rating between 2001 and 2002. Out of the seven streams sampled by ANS, one was ranked as poor (borderline with fair), three stations located on Young's

Branch were all ranked as fair, one station on Little Bull Run and one station on Catharpin Creek were ranked as good, and the station on Walney Creek was ranked as excellent. The ANS station on Big Rocky Run is located near the SOS station on Big Rocky Run. ANS assessed Big Rocky Run as poor (borderline with fair) which corresponds to the SOS assessment of this stream as being unacceptable two out of three times sampled.

## 3.3 Discharge Monitoring Reports

Discharge Monitoring Reports (DMR) for each of the individual permitted facilities discharging into the Bull Run watershed were obtained and analyzed. Permit information and limits are presented in Appendix B; DMR data are presented in Appendix C. A summary of permit exceedances is presented in Table 3-16. These violations include:

- Sunoco Manassas (permit # VA0087858), which exceeded its permit limits for total suspended solids.
- Evergreen Country Club (permit # VA0087891), which exceeded its permit limits for total suspended solids, dissolved oxygen, total Kjeldahl nitrogen, and biochemical oxygen demand.
- Upper Occoquan Sewage Authority (UOSA; permit # VA0024988), which exceeded its permit limits for total suspended solids, chemical oxygen demand, phosphorous, total Kjeldahl nitrogen, and turbidity.

Whole Effluent Toxicity (WET) data was collected at the IBM Corporation facility from December 2001 through June 2004. This facility does not have a maximum WET concentration limit specified in its current NPDES permit.

DRAFT

**Table 3-16: Permit Exceedances from Facilities Discharging in the Bull Run Watershed**

| Facility Name | Permit No. (Outfall No.) | Parameter Description | Period of DMR Records | No. DMRs | DMR Reported Values (Averages) | | | | No. Exceedances of Permit Limits | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Quantity | | Concentration | | Quantity | | Concentration | |
| | | | | | Avg | Max | Avg | Max | Avg | Max | Avg | Max |
| Sunoco Manassas | VA0087858 (1) | Total Suspended Solids | 3/00 – 4/05 | 21 | - | - | 30.11 | - | - | - | 1 | - |
| Evergreen Country Club | VA0087891 (1) | Total Suspended Solids | 2/05 - 6/05 | 77 | 0.12 | 0.18 | 10.76 | 14.2 | 1 | - | 17 | - |
| | | Dissolved Oxygen | 2/99 – 6/05 | 76 | - | - | 7.99 | - | - | - | 6 | - |
| | | Total Kjeldahl Nitrogen | 2/99 – 6/05 | 76 | 0.08 | 0.10 | 7.20 | 7.63 | 11 | - | 42 | - |
| | | cBOD (5 day) | 2/99 – 6/05 | 77 | 0.11 | 0.15 | 10.2 | 13.3 | 4 | - | 25 | - |
| Upper Occoquan Sewage Authority | VA0024988 (1) | Total Suspended Solids | 2/99 – 5/05 | 76 | 46.5 | - | 0.42 | - | 4 | - | 4 | - |
| | | Chemical Oxygen Demand | 2/99 – 5/05 | 76 | 721.61 | - | 7.31 | - | 3 | - | 7 | - |
| | | Total Phosphorous | 2/99 – 5/05 | 76 | 5.17 | - | 0.05 | - | 2 | - | 3 | - |
| | | Total Kjeldahl Nitrogen | 2/99 – 5/05 | 76 | 45.5 | - | 0.43 | - | 4 | - | - | - |
| | | Turbidity | 2/99 – 5/05 | 76 | - | - | 0.29 | - | - | - | 3 | - |

DRAFT

# 4.0 Stressor Identification Analysis

TMDL development for benthic impairment requires identification of pollutant stressor(s) affecting the benthic macroinvertebrate community. Stressor identification for the biologically impaired segment of the Bull Run was performed using the available environmental monitoring and watershed characterization data discussed in previous sections. The stressor identification follows guidelines outlined in the EPA Stressor Identification Guidance (EPA 2000).

The identification of the most probable cause of biological impairment in the Bull Run was based on evaluations of candidate stressors that can potentially impact the river. The evaluation includes candidate stressors such as dissolved oxygen, temperature, pH, metals, organic chemicals, nutrient, toxic compounds, and sediments. Each candidate stressor was evaluated based on available monitoring data, field observations, and consideration of potential sources in the watershed. Furthermore, potential stressors were classified as:

**Non-stressors**: The stressors with data indicating normal conditions and without water quality standard violations, or without any apparent impact

**Possible stressors**: The stressors with data indicating possible links, however, with inconclusive data to show direct impact on the benthic community

**Most probable stressors**: The stressors with the conclusive data linking them to the poorer benthic community. Table 4.1 summarizes the results of the analysis.

**Table 4.1: Summary of Stressor Identification in the Bull Run**

| Parameter | Location in Document |
|---|---|
| **Non-Stressors** | |
| Dissolved Oxygen | Section 4.1.1 |
| Temperature and pH | Section 4.1.2 |
| Metals and Dissolved Organic Chemicals | Section 4.1.3 |
| Nutrients | Section 4.1.4 |
| **Possible Stressors** | |
| Toxicity | Section 4.2.1 |
| **Most Probable Stressors** | |
| Sedimentation and Urban Runoff | Section 4.3.1 |

DRAFT

## 4.1 Non-Stressors

### 4.1.1. Dissolved Oxygen

Adequate dissolved oxygen (DO) levels are necessary for invertebrates and other aquatic organisms to survive in the benthic sediments of rivers or streams. Decreases in instream oxygen levels can result in oxygen depletion or anoxic sediments, which adversely impact the river's benthic community.

Field dissolved oxygen data presented in Figure 3-1 indicates adequate DO levels in the Bull Run. In addition, the DO diurnal study conducted between August 3 and August 5, 2005 shows DO levels above the minimum DO standards with normal diurnal swings of 1 mg/L. Dissolved oxygen does not appear to be adversely impacting benthic communities in the Bull Run, therefore, it is classified as a non-stressor.

### 4.1.2. Temperature and pH

Benthic invertebrates require a suitable range of temperature and pH conditions. Although these ranges may vary by invertebrate phylogeny, high instream temperature values and either very high or very low pH values may result in a depauperate invertebrate assemblage comprised predominantly of tolerant organisms. The Virginia Class IV water quality standards identify the acceptable pH and temperature ranges for the Bull Run. Field measurements indicated adequate temperature and pH values on and upstream of the biologically impaired segment (Figures 3.2 and 3.4). There have been no observed violations of Class III water quality standards for pH and temperature. Temperature and pH do not appear to be adversely impacting benthic communities in the Bull Run and are therefore classified as non-stressors.

### 4.1.3. Metals and Dissolved Organic Chemicals

All available dissolved metals data (arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, and zinc) were below the acute or chronic dissolved freshwater criteria specified in Virginia's aquatic life use standards. In fact, almost all metals parameters analyzed were below analytical detection limits.

Additionally, the sediment metals data collected in the Bull Run watershed complied with the sediment screening values specified in the DEQ 2004 assessment guidance memorandum.

DRAFT

Dissolved organics parameters (aldrin, dieldrin, endosulfan, endrin, DDD, DDE, DDT, PAHs, and PCBs) did not exceed acute or chronic dissolved freshwater criteria specified in Virginia's water quality standards.

Consequently, metals and dissolved organic chemicals do not appear to be primary stressors affecting the benthic macroinvertebrates in the Bull Run.

### 4.1.4 Nutrients

High nitrogen and phosphorus concentrations can stimulate algal growth, which may result in eutrophic conditions, high organic loading, and decreased dissolved oxygen. Low nutrient concentrations were observed in Bull Run, and do not appear to be resulting in significant periphyton growth, which may impact the benthic macroinvertebrates present in the stream. The absence of eutrophication in Bull Run is confirmed by the continuous DO data showing normal diurnal swings of 1 mg/L.

Based on the nutrient data collected and the diurnal DO data suggesting the absence of eutrophication in the Bull Run watershed, nutrients are therefore considered as a non-stressor in the impaired segment of the Bull Run watershed.

## 4.2 Possible Stressors

### 4.2.1 Toxicity

Levels of ammonia, which is toxic to aquatic organisms in high concentrations, were low across all monitoring stations, and suggests that ammonia is not adversely impacting benthic invertebrates in the biologically impaired segments of the Bull Run watershed.

Instream toxicity testing by EPA Region 3 Laboratory indicated no toxic effects on Ceriodaphnia survival and reproduction, or fathead minnow growth. However, minnow survival rates in samples collected at the two monitoring stations on the Bull Run watershed were statistically different than survival rates in the control samples. The EPA Region 3 laboratory indicated that in their professional judgment, the difference in mortality rates between the sample taken at station 1ABUL010.28 and the control was "probably biologically significant." In both instances, the EPA Region 3 laboratory

DRAFT

emphasized that these results were qualitative in nature, and needed to be compared to other available water quality data.

Although the EPA toxicity test results presented above are generally insufficient evidence to suggest the possibility of a direct toxicity effect, the DEQ data suggested the presence of potential toxic pollutants in the watershed. Organic chemicals (non-dissolved) have been noted in sediment samples above screening values specified in the DEQ 2004 assessment guidance memorandum. Sediment PAH (non-halogenated organics) samples at station 1ABUL013.40 were recorded as exceeding the screening criteria for dibenz [A,H]anthracene in 2004. In addition, though below the consensus based sediment screening values specified in the DEQ 2004 assessment guidance memorandum, several PAH compounds at station 1ABUL010.28 have also been noted in samples (chrysene, pyrene, and fluoranthene).

Fish tissue samples from Bull Run have also indicated the presence of PCBs. However, sediment PCB concentrations above the benthic impaired segment are generally low, whereas those below the benthic impaired segment have exceeded sediment screening criteria. Therefore, the source of PCBs identified in fish tissue samples is likely downstream of the segment listed for benthic impairment.

Based on the data presented above and EPA toxicity test results, toxicity cannot be ruled out as a non-stressor and is therefore considered a possible stressor in the impaired segment of the Bull Run watershed.

## *4.3 Most Probable Stressors*

### *4.3.1 Sedimentation and Urban Runoff*

In the Bull Run watershed, habitat assessment scores indicate relatively low riparian-vegetation and riffles-frequency scores in the impaired segment of the Bull Run watershed (Table 3-6). These habitat alterations are a result of increased runoff and stream-bank erosion. In fact, the loss of riparian vegetation and riffle frequency is usually caused by increased urbanization and impervious surfaces in the watershed, which leads to increased overland flow and channel erosion.

DRAFT

The observed biological impairment corresponds with an increase in impervious surfaces as the stream drains higher impervious areas from Cub Run, Big Rocky Run, and Little Rocky Run. The increased imperviousness of urban areas results in less infiltration during precipitation events, and consequently a higher volume of runoff that enters the creek. In fact, the entire Bull Run watershed is 40 percent developed, with much higher development within the immediate drainage area of the impaired segment.

Consequently, the habitat assessment scores indicate that high runoff flows and stream bank erosion are the most probable stressors causing the habitat alterations in the Bull Run watershed.

## *4.4 Stressor Identification Summary*

The data and analysis presented in this report indicate that dissolved oxygen, temperature, and pH, in the biologically impaired segment of Bull Run are adequate to support a healthy invertebrate community, and are not stressors contributing to the benthic impairment. Concentrations of metals and organic chemicals were generally low or below analytical detection limits and are classified as non-stressors. In addition, toxicity was also classified as a non-stressor since toxicity testing suggested the absence of toxicity in the impaired segment Bull Run.

Based on the evidence and data discussed in the preceding sections, sedimentation, caused by higher runoff flows has been identified as a primary stressor impacting benthic invertebrates in the biologically impaired segments of the Bull Run. Habitat scores indicate decreased habitat quality in the impaired segments because of the surrounding urban environment. Potential sources of sediment loading in the watershed include urban stormwater runoff, stream bank erosion, and sediment loss from habitat degradation associated with urbanization.

The interrelation between sedimentation, higher runoff flows, and habitat alteration, allows a TMDL for sediments to address habitat degradation as well as increased urban runoff. Improvement of the benthic community in the biologically impaired segment of the Bull Run watershed is dependent upon reducing sediment loadings through

DRAFT

stormwater control, as well as restoring instream and riparian habitat to alleviate the impacts of urbanization on the river.

Consequently and to address these issues, a sediment TMDL will be developed for the biologically impaired segments of the Bull Run watershed.

DRAFT

# References

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1999. *Guidance for Water Quality-Based Decisions: The TMDL Process.* U.S. EPA, Office of Water, EPA 440/4-99-001, Washington DC.

U.S. Environmental Protection Agency (EPA). 2000. *Stressor Identification Guidance Document*. U.S. EPA, Office of Research and Development, EPA 822-B-00-025, Washington, DC.

U.S. Environmental Protection Agency (EPA). 2001. "Overview of Current Total Maximum Daily Load (TMDL) Program and Regulations." Available at: <http://www.epa.gov/owow/tmdl/overviewfs.html>.

U.S. Environmental Protection Agency (EPA). 2001. Better Assessment Science Integrating Point and Non-point Sources (BASINS), Version 3 Washington, DC.

U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). 2000.STATSGO Soils Browser CD-ROM Version 1.0.

U.S. Environmental Protection Agency (EPA). 2004. *VADEQ TMDL Study 12 Roanoke River, South Run, Popes Head Creek, and Bull Run.* U.S. EPA, Wheeling Office, Wheeling WV.

U.S. Environmental Protection Agency (EPA). 2005. *VADEQ TMDL Study 16 Bull Run, Pope's Head Creek, South Run, and Jackson River*. U.S. EPA, Wheeling Office, Wheeling WV.

Virginia. *Virginia Administrative Code*. 2004. VAC 25-260-5 et seq. Water Quality Standards. Available at: < http://www.deq.state.va.us/wqs/WQS03Aug.pdf>.

Virginia Department of Environmental Quality (DEQ). 2001. "Total Maximum Daily Loads, Background-Legal and Regulatory Framework." Available at: <http://www.deq.state.va.us/tmdl/backgr.html>.

Virginia Department of Environmental Quality (DEQ). 2002. *2002 Water Quality Assessment Report, Part III Surface Water Monitoring.* Available at: <http://www.deq.state.va.us/wqa/305b.html>.

DRAFT

Virginia Department of Environmental Quality (DEQ). 2002. *Virginia List of Impaired Waters.* Virginia DEQ, 2002

Virginia Department of Environmental Quality (DEQ). 2004. *Virginia 2004 Water Quality Assessment 305(b)/303(d) Integrated Report.* Available at: <http://www.deq.virginia.gov/wqa/pdf/2004ir/mnstat4.pdf>.

Virginia Department of Environmental Quality (DEQ). 2004. *Virginia Department of Environmental Quality Guidance Memo No. 04-2006: 2004 Water Quality Assessment Guidance Manual.* From: Larry G. Lawson, P.E., Director, Division of Water Quality. Available at: <http://www.deq.virginia.gov/waterguidance/pdf/042006.pdf>.

Woods, A. J., Omernik, J. M., and D. D. Brown. 1999. *Level III and IV Ecoregions of Delaware, Maryland, Pennsylvania, Virginia, and West Virginia.* U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory. Corvallis, OR.

DRAFT